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THE DEVELOPMENT OF DETAILED CHARACTERIZATION OF LIQUID HAZARDOUS WASTE STREAMS GENERATED BY ILLINOIS INDUSTRIES

Document No. HW 84/01

ENR

Illinois Department of
Energy and Natural Resources

James R. Thompson, Governor
Michael B. Witte, Director

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THE DEVELOPMENT OF DETAILED CHARACTERIZATION OF LIQUID HAZARDOUS WASTE STREAMS GENERATED BY ILLINOIS INDUSTRIES

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PROJECT NO. 83/1201

James R. Thompson, Governor
State of Illinois

Michael B. Witte, Director
Department of Energy and
Natural Resources

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[1] Performed under contract with the Illinois Department of Energy and Natural Resources as contract number HF 2 to Franklin Associates, Prairie Village, Kansas.

[2] Performed by Midwest Research Institute staff contract by Illinois Department of Energy and Natural Resources under contract HF 2 to Franklin Associates.

[3] Contributing authors with the Illinois Department of Energy and Natural Resources.

NOTE

Pursuant to Illinois Revised Statutes 1980 Ch. 111 1/2, Section 1022.2(e), the Illinois Department of Energy and Natural Resources administers the Hazardous Waste Research Program (HWRP) which is aimed at developing alternatives to landfilling hazardous wastes in Illinois.

Conduct of this study and publication of this report represents the Department's initial efforts in fulfilling the above legislative mandate.

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PREFACE

This reports presents the results of a study performed for the Illinois Department of Energy and Natural Resurces. The prime contractor was Franklin Associates, Ltd., with Midwest Research Institute as a major subcontractor. The purpose of the study was to:

1. Characterize off-site managed liquid hazardous wastes generated and disposed in Cook, DuPage, and Lake Counties in Illinois, and
2. Identify and evaluate waste management options for selected waste streams identified in (1) as being of major importance.

The report summarizes the study and the results therefrom. Additional details and a large volume of data obtained and developed in the study are presented in four appendices. The data in the appendices are arranged in a readily accessible manner.

Franklin Associates, Ltd. (FAL) key staff were Robert Hunt, Project Manager, Nicholas Artz, Project Leader, Jere Sellers, Richard Young, and Richard Welch. Midwest Research Institute (MRI) key staff were Thomas Ferguson, MRI Project Manager, Thomas Lapp, Raju Kakarlapudi, and Fred Hopkins.

We gratefully acknowledge the assistance and direction provided by Mr. William Frerichs and Mr. Ram Reddy of the Illinois Department of Energy and Natural Resources in the performance of the study and development of this report.

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EXECUTIVE SUMMARY

PRELIMINARY ASSESSMENT

In 1982 industries in Cook, DuPage, and Lake Counties in the Chicago area generated an estimated total of over 34 million gallons of liquid hazardous wastes that were managed off-site.* The quantity generated from each of these counties is illustrated in Figure E-1. Cook County generated nearly 90 percent of the total (over 30 million gallons) whereas DuPage County generated the least, at less than 2 percent (about 550,000 gallons).

Land disposed liquid hazardous wastes managed off-site in the three-county area in 1982 are estimated at nearly 22 million gallons (Figure E-2). Approximately 12.5 million gallons of this total are generated in the three-county area. Most of the remainder is from industry outside of the area (some from outside Illinois).

The identified waste categories by quantities generated versus quantities land disposed in the three-county area are compared in Figure E-3. Acidic wastes and alkaline wastes are far greater than the other waste categories in quantities generated. Other major generation categories include paint wastes, solvent wastes, distillation residues, plating wastes, metal wastes, hydrocarbons, and wastes within the miscellaneous category. The most prominent land disposed waste category is alkaline wastes--with an even greater quantity land disposed than generated. Other major land disposed waste categories include hydrocarbon wastes, distillation residues, plating wastes, and miscellaneous wastes including oil-contaminated wastes and selected treatment sludges.

Where generated waste quantities shown in Figure E-3 are greater than the corresponding land disposed amounts, some of the generated waste is presumably disposed of outside of the three counties or managed in another manner. Where land disposed quantities are shown to be greater than generation, waste is apparently imported into the three-county area for disposal.

Several commercial treatment facilities located in the three-county area receive larger quantities of acidic wastes (pickle liquors, etc.), generated both within and outside the area. The alkaline sludges (metal hydroxides) resulting from these facilities account for the majority of the alkaline wastes land disposed in the three counties.

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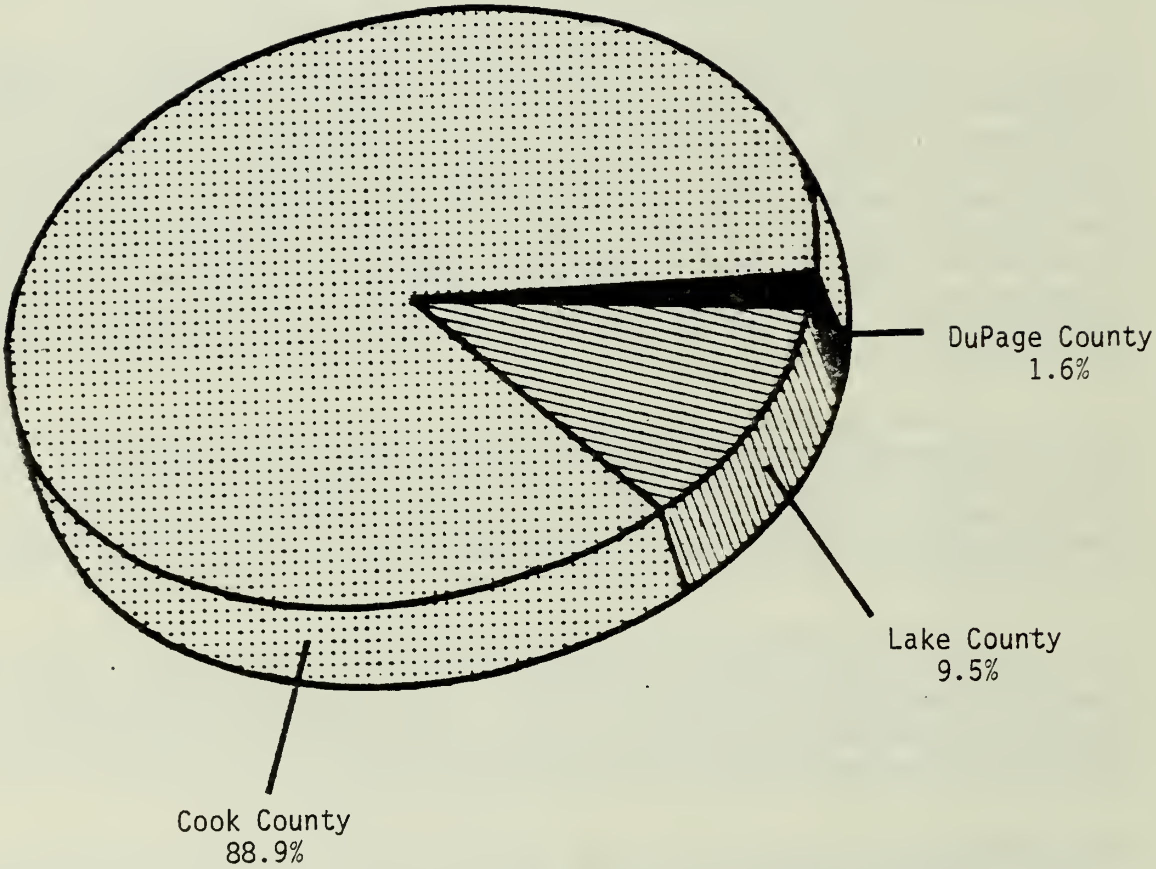
* Wastes managed on-site were not evaluated in this study; such data were not made available.



Total Quantity Generated:*
34 million gallons

Figure E-1. Quantities of liquid hazardous waste generation* in Illinois three-county area.

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* Refers to generated wastes which are managed off-site.

COMPREHENSIVE ASSESSMENT

Ten liquid hazardous waste streams land disposed within the three counties were evaluated in detail. The objective of these evaluations was the identification of feasible alternatives to land disposal. The ten waste streams examined, and the waste categories in which they are included, are:

1. Metal Hydroxide Sludge from Typical Commercial Treatment (RCRA numbers based on presence of heavy metals); alkaline waste
2. Metal Hydroxide Sludge from Extended Lime Treatment (RCRA numbers based on presence of heavy metals); alkaline waste
3. Wastewater Treatment Sludge from Electroplating Operations (RCRA Number F006); plating waste
4. Petroleum Refining Sludges (RCRA Numbers K048, K049, K050, K051); miscellaneous waste
5. Petroleum Distillates and Solvents/Chromium Wastes (RCRA Numbers D001, D007); solvents and metal wastes

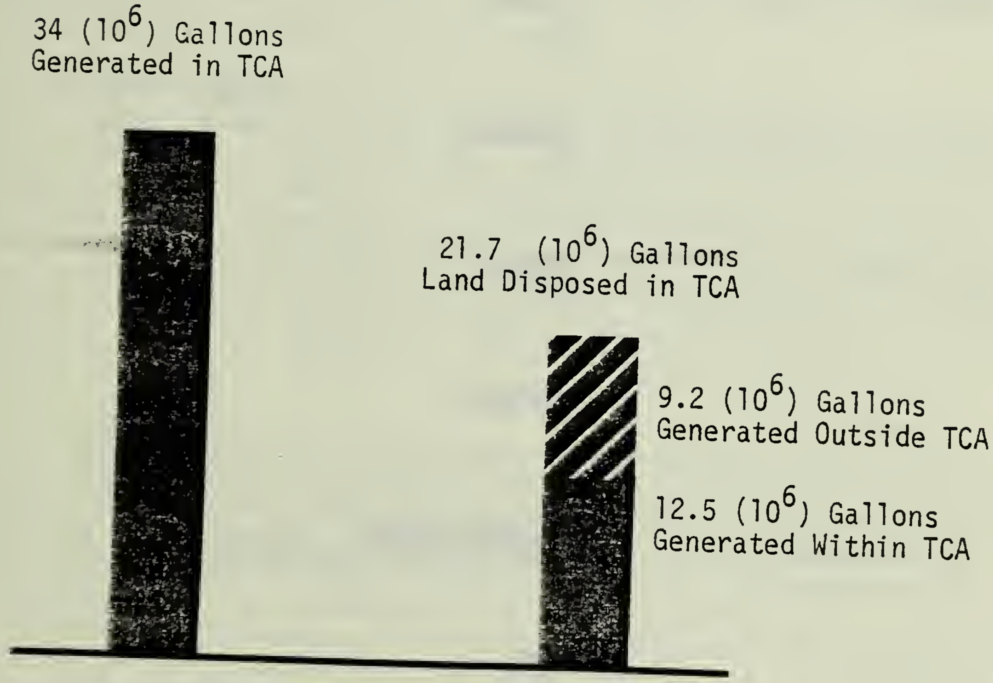

Figure E-2. Comparison of liquid hazardous waste generation and land disposal in the Three-County Area (TCA).

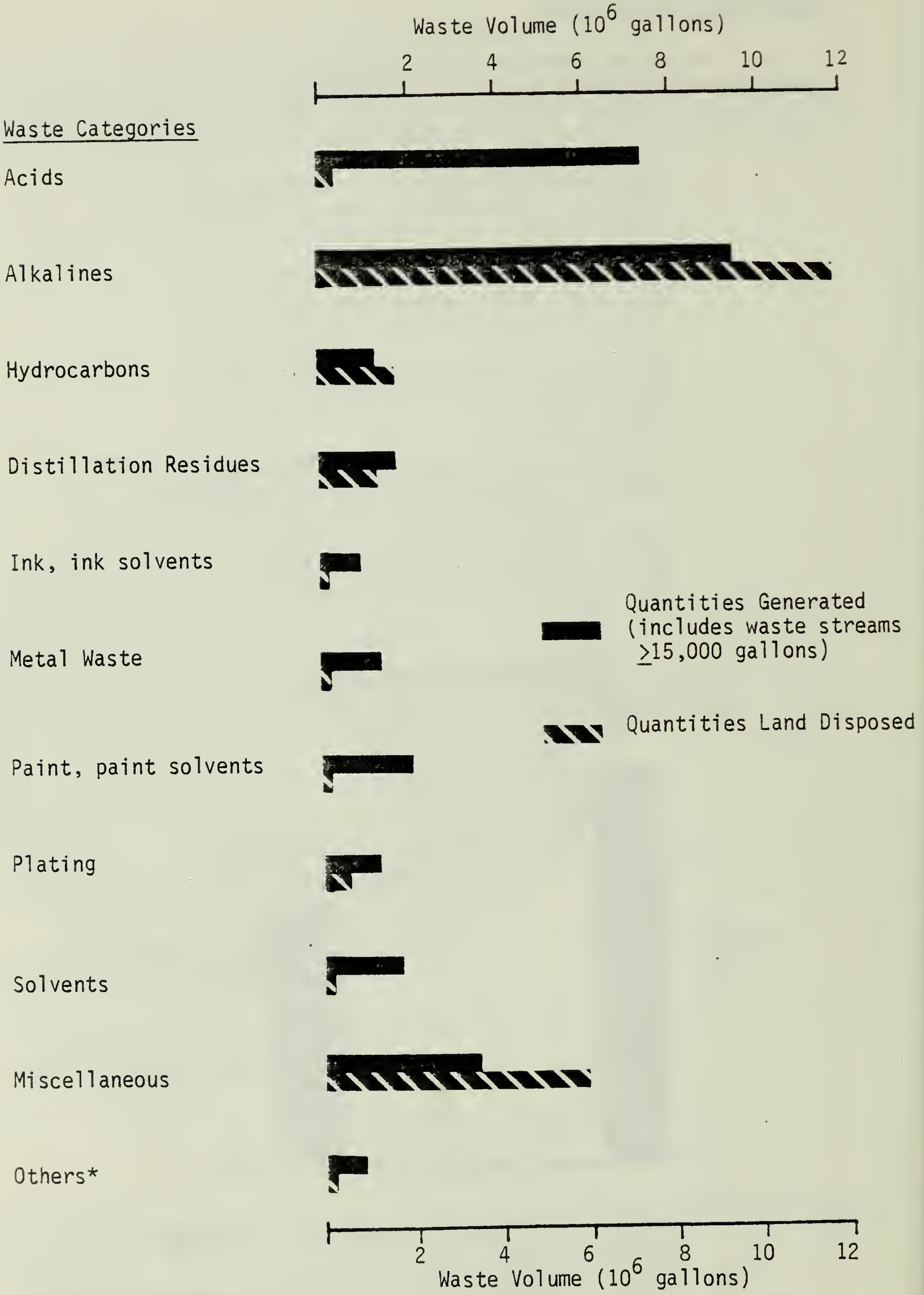

Figure E-3. Comparison of liquid hazardous waste generation and land disposa in Cook, DuPage, and Lake Counties (1982).

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* Includes the following categories: alcohols, aromatic hydrocarbons, chemica intermediates, heat treating salts, paint strippers, and polymer waste.

6. Aniline Wastes from Still Bottoms (RCRA Number K083); distillation residues

7. Waste Solvents (RCRA Numbers F001, F002, F003, F005); solvent waste

8. Ink-Related Wastes (RCRA Numbers D007, D008, F003, F004, K086); ink, ink solvents waste

9. Concentrator Tailings from Secondary Brass Refining (RCRA Number D008); miscellaneous waste

10. Emission Control Sludges from Secondary Production of Steel (RCRA Number K061); miscellaneous waste

The first two waste streams listed are generated from the commercial treatment of acidic and alkaline wastes containing heavy metals. The most feasible waste management alternative to land disposal for these waste streams is stabilization/solidification treatment. Such treatment binds the hazardous materials to nonhazardous additives thereby preventing the leaching of these wastes into water supplies. The estimated cost of stabilization/solidification treatment of the metal hydroxide sludges from commercial treatment addressed here is little (if any) more than "secure" landfilling. This includes the cost of disposing of the treated sludge in a nonhazardous landfill. The long-term integrity of the treated sludges is promising but not totally proven. Obtaining a permit to dispose of stabilized wastes in a nonhazardous landfill may be a concern in some areas.

The wastewater treatment sludge from electroplating addressed here is also hazardous because of heavy metals. Stabilization/solidification treatment is not as economical for this sludge because the low quantities would require off-site commercial treatment, which would increase total waste transportation costs. However, some in-house metal recovery techiques to reduce the sludge quantity appear feasible. Recovery of cadmium, copper, chromium, and nickel from electroplating rinse waters appears cost-effective and will reduce the quantity of sludge generated. Several of the metal recovery techniques are commercially proven and newer procedures are appearing, as well.

Petroleum refining sludges may contain numerous heavy metals in addition to oil and phenols. Measures which may be effective in reducing land disposal of petroleum refining sludges include process modifications, segregation of hazardous and nonhazardous waste streams, improvements in in-house treatment, and recovery of selected materials. These measures may be cost-effective at some refineries, but must be addressed on a site-specific basis. Incineration is another alternative for refining sludges, but the cost is, typically, at least twice that for land disposal. However, if the excess heat from burning the sludges can be used, incineration may be less expensive than land disposal.

The chromium wastes examined in the study were chromate-contaminate washwater and a chromium sludge, both generated in small quantities. The cos of commercial treatment (including a proprietary process of stabilization/solidification) is judged to be less expensive than land disposal for the chromium sludge. Miscellaneous petroleum distillates and solvents are, in the case examined, generated in conjunction with the chromium wastes and were also evaluated. Incineration of these organic wastes is a plausible alternative but probably more expensive than land disposal.

Aniline recovery blue pitch is generated from the manufacture of alkali blue pigment used in paint manufacturing. The primary constituent of this waste is aniline. The heat energy content of the waste is estimated at 14,000 Btu per pound. With its high energy content, aniline recovery blue pitch may be used as a fuel either in on-site or off-site boilers. The waste can be mixed, when hot, in fuel oil. Use of this waste as a secondary fuel will eliminate disposal costs and may, further, be a source of revenue.

Waste solvents are typically sent to solvent reclaimers. A reclaimer may generate two waste streams that are landfilled or disposed of by deepwell injection: wastewater and dewatered filter cake. A solvent reclaimer generating large quantities of these wastes may conceivably find waste management alternatives that are less expensive than land disposal. The inorganic filter cake (contaminated with heavy metals) may be subject to on-site stabilization/solidification treatment. Biological treatment of the wastewater appears potentially less expensive than current deepwell injection.

Ink-related wastes from the formulation of inks and newspaper publication were evaluated. These include ink sludges, recoverable and nonrecoverable solvents, and wastewater. Nonrecoverable solvents are often used as sources of secondary fuel and some of the recoverable solvents may be sold to solvent reclaimers. One newspaper publisher is currently using an in-house filtration process to reclaim materials from ink sludge and cleanup solvents. The remaining wastes (one-third of the original quantity) are land disposed. This process is considerably less expensive than disposing of the original quantities in a secure landfill.

Concentrator tailings are inorganic wastes from the production of secondary brass. They contain zinc, copper, and lead. A promising alternative to landfilling concentrator tailings is to pelletize them and place them back in the smelters. Several pelletizing techniques have been used in the steel industry. The applicability of these techniques to secondary brass production is unproven but seems to have potential. If so, pelletizing concentrator tailings is expected to be a lower cost alternative than landfilling. Other waste management alternatives to landfilling concentrator tailings may also hold promise depending upon the quantities generated.

The final waste stream evaluated is emission control dust/sludge from secondary steel production. This waste is referred to as dust if collected in baghouse filters and sludge if collected in wet spray scrubbers. The dust is almost all solids while the sludge is perhaps 60 percent solids. The high concentrations of metals (particularly zinc) in the dust result in this waste being conducive to recovery of certain metals. Instead of a cost for disposal, recovery of metals may result in a net profit. For sludges, the aforementioned stabilization/solidification techniques may be more expensive than currently indicated landfilling costs for these wastes. Another such technique, called the Armco Phosphate Fixation process, is estimated to result in costs similar to other stabilization procedures.

All of the waste management alternatives evaluated and reported here have been compared to current prices for land disposal. It is not clear, based upon past land disposal practices that have led to environmental damage and costly cleanup, if the current land disposal prices reflect the actual long-term cost of this practice. Thus, some of the waste management alternatives to land disposal may, in fact, be more preferable by comparison than indicated.

PROJECTED LAND DISPOSAL IN THE THREE-COUNTY AREA

The results of the detailed waste stream evaluations suggest that feasible waste management alternatives exist for large quantities of liquid hazardous wastes currently being land disposed. Estimated quantities of off-site managed liquid hazardous wastes land disposed in the three-county area in 1982, which could feasibly be managed alternatively, are shown in Table E-1. Projected future land disposal in the area with these reductions are also shown.

The hazardous waste quantities land disposed in the three counties in 1982 for which feasible alternatives are judged available, total nearly 12.5 million gallons. This leaves only 9.3 million gallons of off-site managed hazardous waste for continued land disposal if the feasible alternatives are fully utilized. The greatest potential reduction in land disposal is shown for the alkalines waste category. This reduction assumes the use of stabilization/solidification treatment for large quantities of metal hydroxide sludges generated at commercial waste treatment facilities which neutralize acidic wastes. While stabilization/solidification will not reduce waste quantities, the treated product is expected to be acceptable in a nonhazardous waste landfill.

Other feasible waste management alternatives to land disposal for the evaluated liquid hazardous waste streams include:

- Metal recovery techniques used on electroplating rinse waters
- Combustion of certain organic wastes as a secondary fuel (e.g., aniline waste)

Table E-1

PROJECTED LAND DISPOSAL OF OFF-SITE MANAGED LIQUID HAZARDOUS WASTES IN THE THREE-COUNTY AREA

Waste Categories	Estimated Quantities with Feasible Alternatives to Land Disposal (gallons)	Projected Future Land Disposal (gallons)
Acids	-	239,865
Alcohols	-	9,456
Aliphatic HC	-	0
Alkalines	9,287,331	2,413,006
Aromatic HC	-	15,849
Chemical intermediates	-	0
Hydrocarbons	-	1,649,114
Distillation residues	1,115,627	173,129
Heat treating salts	-	15,000
Ink, ink solvents	23,716	19,964
Lab wastes	-	0
Metal wastes	60,747	54,345
Paint, paint solvents	-	139,909
Paint strippers	-	14,120
Paper manufacture	-	0
Pesticides	-	0
Photographics	-	0
Plating	80,920	365,681
Solvents	25,700	106,200
Miscellaneous	1,855,281	4,071,377
Industrial formulations	-	0
Polymer wastes	-	23,624
Total	12,452,322	9,301,639

Source: Franklin Associates, Ltd.

- Recovery of newspaper publishing ink/ink solvent wastes
- Recovery of concentrator tailings through pelletizing.

The time required to effect the potentially feasible reductions in land disposed hazardous waste is unknown. However, some reductions from the 1982 quantities have already been noted. In addition, the cost for land disposal of hazardous wastes is expected to continue increasing above inflationary levels and the cost effectiveness of alternatives to land disposal will become more evident.

INTRODUCTION

The Illinois Department of Energy and Natural Resources (ENR) administers the Hazardous Waste Research Program which was initiated in the spring of 1983. The principal objectives of this program are to compile an accurate data base; to develop an accounting of hazardous wastes either generated or managed in Illinois; to develop comprehensive information on the chemical and physical characteristics of hazardous wastes, including the relevant process information pertinent to the generation or management; to initiate or effect safe or less harmful management practices to protect human health and environment; and to provide technical assistance and facilitate information exchange to industrial and public sectors.

A multi-phased program aimed at fulfilling the above objectives was developed. One of the program elements includes making an accurate qualitative and quantitative assessment of hazardous wastes generated or managed in Illinois, cataloging pertinent process information, and identifying state-of-the-art waste reduction or disposal alternatives.

Liquid hazardous wastes are of concern because of their quantities, degree of hazard, and ability to leach into groundwater when disposed in landfills. In Illinois a major portion of the liquid hazardous wastes is generated or disposed in Cook County and counties adjacent to Cook County. Therefore, Cook, DuPage, and Lake Counties in the Chicago area were selected as the area for initial study. Through a solicitation process, Franklin Associates, Ltd. and Midwest Research Institute were selected as technical consultants and contractors to conduct a study entitled, "The Development of Detailed Characterization of Liquid Hazardous Waste Streams Generated by Illinois Industry."

STUDY PLAN

As required by Illinois Revised Statutes 1980 CL. 111 1/2, Section 1022.2(c), the Illinois Department of Energy and Natural Resources (ENR) administers a Hazardous Waste Research Program aimed at developing alternatives to landfilling hazardous wastes in Illinois. The basic objective of this study is to assist ENR in this task by developing an information base for industries in Cook, DuPage, and Lake Counties on liquid hazardous waste generation* and current treatment/disposal practices, and to determine waste management alternatives to land disposal.

The study was divided into two phases. Phase 1 consisted of a preliminary assessment of available information from the Illinois Environmental Protection Agency (IEPA) on hazardous waste generation and management in the three-county area. Phase 2 consisted of a comprehensive assessment of the industries generating liquid hazardous waste, processes leading to waste generation, waste stream composition, and evaluation of waste management alternatives.

The data used in the Phase 1 Preliminary Assessment included RCRA Part A data obtained from the U.S. EPA, 1982 Annual Reports filed with IEPA by generators and facilities managing hazardous wastes, Hazardous Waste Inventory Sheets, Chicago Metropolitan Sewer District (M.S.D.) data, and information applied directly by industries. By compiling and reviewing the data lists of industries, types of waste, and quantities of waste were developed. An assessment of this data led to a determination of the areas for concentrated study in Phase 2.

In the Phase 2 Comprehensive Assessment, selected industries and their respective processes and waste streams were examined in detail. Process descriptions and flowsheets were developed for those industrial processes generating the waste streams of concern. Waste stream quantities and physical and chemical characteristics were also developed. Current waste management practices were identified, and alternative waste management practices were evaluated. The evaluation of waste management alternatives was based upon technical, economic, and regulatory criteria.

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* The "generation" of hazardous wastes, as used in this report, refers to generated wastes which are managed off-site. Quantities of hazardous wastes which are managed on-site (i.e., at their source) are not included because data have not been collected.

This report presents the findings from the Phase 1 and Phase 2 efforts in the study. Current hazardous waste generation and management practices in Cook, DuPage, and Lake Counties are summarized in the Phase 1 discussion. The ten waste streams for which detailed evaluations were undertaken are described in the Phase 2 presentation. The evaluation of each waste stream and corresponding waste management alternatives are summarized in individual sections of Phase 2. Each section contains a comparative presentation of the waste management alternatives for the waste stream examined, including the currently used land disposal alternative. Detailed discussions of the waste stream evaluation results are contained in Appendix A.

The detailed supporting data developed in Phase 1 are also contained in the accompanying Appendices. For those establishments on record as generating or disposing of liquid hazardous wastes in the three-county area in 1982, the types of waste stream(s) and quantities are readily accessible. Computer listings of the identified waste streams organized by industry groupings and waste categories are contained in Appendix B. Computer printouts were also developed which list waste stream data (for each county) by:

1) Waste quantity (in descending order)
2) RCRA waste type
3) Company name (in alphabetical order)
4) Waste management practice.

The computer printouts containing this and other data on waste stream generation and management in the three-county area are enclosed in Appendices C and D. The printouts are divided into those from Generator Annual Reports (Appendix C) and those from Facility Annual Reports (Appendix D).

It is anticipated that the findings from the study will be of value to both government and industry. An up-to-date accounting of liquid hazardous wastes which are generated and/or managed off-site in the three-county area will be useful in planning improvements to the hazardous waste management system. In addition, identification of feasible hazardous waste management alternatives to land disposal should be beneficial in improving hazardous waste management practices and reducing land disposal.

NOTE: Data presented in appendices B, C, and D are assembled from 1982 hazardous waste generator reports, submitted by Illinois industries to IEPA, which are construded to contain proprietary or confidential information of individual industries. Therefore, these appendices are not available for general distribution.

Appendix A has been printed separately and a limited number of copies are available upon request from the Department of Energy and Natural Resources, Clearinghouse, 325 W. Adams, Springfield, Illinois 62706 (217) 785-8580.

PRELIMINARY ASSESSMENT

DESCRIPTION OF ACTIVITIES

Sources of Hazardous Waste Generation and Management Data

Documented Sources. The initial effort in this study was acquiring compiling, and reviewing existing data on liquid hazardous wastes generated and disposed in Cook, DuPage, and Lake Counties. An information base was developed from data provided on those industries generating, processing, and disposing of liquid hazardous wastes in these counties. The data included Illinois EPA Generator and Facility Annual Reports, the Part A data of the RCRA permits from U.S. EPA Region V, Illinois EPA hazardous waste inventory sheets, Chicago Metropolitan Sewer District data, and information supplied directly by industries.

After reviewing the available data on hazardous wastes in Illinois information contained in the 1982 Annual Reports was determined to be the most recent and comprehensive.* (Annual reports are submitted both by generators and those treatment and disposal facilities regulated under RCRA.) Relevant data contained in these annual reports were manually transferred to computer disks. From this data base several sets of computer printouts were developed. Waste stream data were listed by waste quantity (in descending order), RCRA waste type, company (in alphabetical order), and waste management practice.

Telephone Contacts. To verify the amount, type, and disposition of wastes, telephone contacts were made with companies in several industries. Approximately 80 phone calls were made to various companies, with 63 of the phone calls providing relevant and useful information. The companies contacted cover each industry group and the majority of the waste categories listed on Table 4 in Appendix B.

Aggregation of Hazardous Waste Generation and Management Data

Three-County Area Generation. The data from the 1982 Illinois EPA Generator Annual Reports were initially transferred to computer disks for subsequent retrieval in various sorted forms. The following types of information were stored on the disks:

- Company name
- Waste description

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* IEPA first utilized the Annual Report system in 1982; therefore, errors and discrepancies were observed in the Reports.

- RCRA hazardous waste number
- Annual quantity (in gallons)
- Whether mixed or not mixed with another waste
- Annual report number identification
- Location by county.

This information was sorted and tabulated for each county as follows:*

- Waste quantity (in descending order)
- RCRA hazardous waste number
- Company name (in alphabetical order).

To further analyze waste generation, the waste streams were sorted into selected industry groups and waste stream categories for each of the three counties.

The nine selected industry groupings were:**

- Adhesives and resins
- Foundries
- General manufacturing and fabrication
- Paint
- Plating
- Printing
- Petroleum refining
- Primary steel production
- Miscellaneous.

The selected waste categories for liquid hazardous waste generation in the three-county area were:†

- Acids
- Alcohols
- Alkalines
- Aromatic hydrocarbons
- Chemical intermediates
- Hydrocarbons
- Distillation residues
- Heat treating salts
- Ink, ink solvents
- Metal wastes
- Paint, paint solvents

---

* See Appendix C.

** See Appendix B, Table 1.

† See Appendix B, Table 2.

- Paint strippers
- Plating wastes
- Solvents
- Polymer wastes
- Miscellaneous.

After the major generation waste categories and industry groups within the three-county area were identified, it was necessary to determine those wastes disposed on land. This was important in deciding which industries and waste types should be examined in Phase 2 to effect the greates reduction in land disposal.

Three-County Area Management. The data from the 1982 Illinois EPA Facility Annual Reports were also transferred to computer disks for subsequent retrieval in various sorted forms. The same information reported on the Generator reports was also recorded on the Facility Reports, along with the U.S. EPA handling code for treatment and disposal of each waste.

This information was sorted and tabulated for the three counties b

- Waste quantity (in descending order)
- RCRA hazardous waste number
- Company name (in alphabetical order).

The above sorting was performed twice--once for land-based disposal practices and once for all other treatment and disposal practices within the three-county area, except solvent recovery.**

The data supplied from the Illinois EPA Facility Annual Reports wer verified by a telephone survey. Confirmation of waste disposal practices fro 45 establishments that filed Generator Annual Reports was also obtained. The land disposal waste quantities determined from these two sources were then arranged within the previously designated industry groups and waste categories. The listings of land disposed hazardous waste by waste category and by industry group are shown respectively on Tables 3 and 4 in Appendix B.

The summary tables showing waste generation and management in the three-county area have since been modified to account for information obtained through industry contacts in Phase 2. For selected waste categories, changes of considerable magnitude have been made, due to numerous errors or changes in the amounts shown in the IEPA Annual Reports. These errors or changes resulted from companies misunderstanding the forms or from actual changes in operation of various facilities.

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* See Appendix D.

** Most data relating to solvent recovery systems were not made available for this study. So while a few examples of solvent recovery are mentioned, the majority are not reported.

Selection of Waste Stream Evaluations for Phase 2

The following criteria were established to select waste streams for evaluation in Phase 2:

1) Waste quantities land disposed
2) Hazard potential of the waste
3) Degree of industry cooperation.

Waste quantities land disposed was a major criterion in the waste stream evaluation. By researching those industries which dispose the largest quantities, the most important waste streams would be evaluated. While all hazardous waste is of concern, quantity alone is not sufficient in selecting waste streams for detailed evaluation; therefore the hazard potential of the waste stream became the second criterion. Consideration of both hazard potential and quantity leads to defining those waste streams of greatest importance relative to environmental effects of land disposal. Cooperation from those industry(s) generating a selected waste stream is necessary to obtain details which are vital for an accurate evaluation. Therefore industry cooperation was the third criterion.

A review of the data and consultations with the Illinois ENR resulted in a listing of waste streams and corresponding industrial waste generators for evaluations in Phase 2. A letter from the Illinois Department of Energy and Natural Resurces was sent to each industrial establishment on the list. The letter explained the ENR hazardous waste research program, identified the current study, and stated that consultants retained for conducting the study would be contacting them to discuss the possibility of obtaining information pertinent to their waste stream. It was stressed that any confidential or proprietary information would be treated as such, and that no site-specific information would be provided to Illinois EPA or any other government agency without the company's approval. During the subsequent telephone contacts, most companies indicated a willingness to meet. Many of the firms not desiring to meet still provided useful information.

The next step was to prepare a detailed work plan for Phase 2--the comprehensive assessment of hazardous waste generation and management.

Development of Phase 2 Work Plan

The work plan for Phase 2 highlighted the objectives of the study, described the specific tasks to be performed and the methodology to be employed, and presented a time schedule. The methodology followed in the Phase 1 Preliminary Assessment and the findings from Phase 1 work were summarized. Recommended companies and waste streams to be evaluated in Phase 2 were listed. Tasks to be performed in Phase 2 were listed as follows:

Task 1: Obtain data on selected waste streams and industries
Task 2: Process description flowsheets
Task 3: Identify hazardous waste stream quantities and characteristics
Task 4: Identify alternative waste management practices
Task 5: Integrate information and data into a user-oriented retrieval system

A description of each of these tasks was developed and examples of expected results were presented. The technical, economic, and regulatory criteria to be used in waste management alternatives evaluation were described. A projec schedule and level of effort were also included. The work plan was reviewed and approved by the ENR staff before the consultants began the Phase 2 work.

SUMMARY OF FINDINGS

Hazardous Waste Quantities in Three-County Area

One of the major objectives of this study was the development of an information base on liquid hazardous waste generation and management in Illinois. This information base was confined to Cook, DuPage, and Lake Counties in the Chicago area. Hazardous wastes generated or managed in the three-county area were quantified and sorted into various categories including waste type, industry grouping, and current waste management practice. The following descriptions summarize the information base developed.

Hazardous Waste Generation Arranged by Industry Group. It should be reiterated that the "generation" of hazardous wastes, as used in this report, refers to generated wastes which are managed off-site. Quantities of hazardous wastes which are managed on-site (i.e., at their source) are not included.

Estimated total quantities of liquid hazardous waste generated in Cook, DuPage, and Lake Counties in 1982 are shown in Table 1. A summary description of this table is provided in the following paragraphs.

Quantity. In 1982, industries in the initial three-county study area generated an estimated total of just over 34 million gallons of liquid hazardous wastes managed off-site. Over 30 million gallons of this total were from Cook County and just over 500,000 gallons were from DuPage County. Approximately 3.2 million gallons were from Lake County.

Industry Groups. Industry groups generating major portions of the three-county total include foundries, general manufacturing and fabrication, paint manufacturing, plating, primary steel production, and miscellaneous industries. These six major industry groups account for approximately 90 percent of the total waste generation in the three-county area.

Table 1

LIQUID HAZARDOUS WASTE GENERATION ARRANGED BY INDUSTRY GROUP AND COUNTY*

(1982)

COOK COUNTY	Gallons
1. Adhesives and Resins	549,311
2. Foundries	3,583,903
3. General Manufacturing and Fabrication	3,706,693
4. Paint	3,406,752
5. Plating	3,184,832
6. Printing	1,340,223
7. Refining and Petroleum Wastes	777,902
8. Primary Steel Production	4,723,400
9. Miscellaneous	8,980,803
Total	30,253,819

DU PAGE COUNTY	Gallons
1. Adhesives	4,000
2. General Manufacturing and Fabrication	485,206
3. Paint	1,030
4. Plating	15,613
5. Printing	43,273
Total	549,122

LAKE COUNTY	Gallons
1. Foundries	357,944
2. General Manufacturing and Fabrication	1,053,903
3. Paints	1,214,562
4. Plating	23,025
5. Printing	594,370
Total	3,243,804
THREE-COUNTY TOTAL	34,046,745

Note: Data are only for generated wastes managed off-site.

* See Table 1, Appendix B for detailed data.

Source: Franklin Associates, Ltd.

The largest quantity, generated from the miscellaneous industry grouping, consists mostly of metal hydroxide sluges from treatment facilities (discussed later). Contrary to the results from a recent nationwide U.S. Environmental Protection Agency survey, a relatively small quantity of hazardous wastes appears to be generated from the chemical industry in the three-county area. This is in part because there is little chemical industry activity in the three-county area, and in part because these industries manage their wastes on-site and are not included in this study.

Hazardous Waste Generation Arranged by Waste Category. Liquid hazardous wastes generated annually in the three counties are divided into waste categories (or types) in Table 2. Only waste streams equal to or greater than 15,000 gallons are shown in Table 2, but they account for nearly 31 million gallons, or 91 percent of the total from Table 1.

Duplication of Waste Accounting. Generator reports are filed by industry and treatment/disposal facilities which generate a waste by-product. These treatment/disposal facilities accept waste from industrial generators and generate a different waste. This results in double counting some waste. This double counting is clearly illustrated in the acidic and alkaline waste categories.

The two waste categories with the greatest quantities are acidic wastes and alkaline wastes. Very little of the acidic wastes is disposed of directly on land. Instead, acidic wastes typically are recovered for reuse or are neutralized. Many of the acidic wastes are pickling liquors or acidic cleaning solutions containing heavy metals. The resulting metal hydroxide sludges account for much of the alkaline wastes shown in Table 2. Thus, many of the materials in the acidic wastes category are later counted in the alkaline wastes category as well. This duplication should be kept in mind when reviewing the summary tables of waste generation. Duplication does not occur in analyzing the land disposed quantities.

Land Disposal in Three-County Area. Estimated total quantities of liquid hazardous wastes that were land disposed in Cook, DuPage, and Lake Counties in 1982 are shown in Table 3. A summary description of this table is provided in the following paragraphs.

Quantity. The land disposed liquid hazardous wastes in the three-county area totaled nearly 22 million gallons in 1982. Approximately 12.5 million gallons of this total are from waste streams of 15,000 gallons or greater generated in the three-county area (see Table 4, Appendix B). Most of the remainder is from industry outside of the area (some from outside Illinois).

Of the 12.5 million gallons of liquid hazardous waste both generated and land disposed in the three-county area in 1982, nearly 9 million gallons are metal hydroxide sludges. One treatment facility in the area is estimated to generate approximately 7 million gallons of this sludge,

Table 2

SUMMARY OF GENERATED LIQUID HAZARDOUS WASTE STREAMS OF 15,000 GALLONS OR GREATER*
(1982)

	Cook		DuPage		Lake		Total	
Waste Categories	No. of Waste Streams	Gallons	No. of Waste Streams	Gallons	No. of Waste Streams	Gallons	No. of Waste Streams	Gallons
1. Acid	34	7,331,321	2	40,246	1	22,177	37	7,393,744
2. Alcohol	2	50,550	0	NA	1	115,000	3	165,550
3. Aliphatic HC	0	NA	0	NA	0	NA	0	NA
4. Alkaline	16	9,364,903	1	37,345	0	NA	17	9,402,248
5. Aromatic HC	1	16,551	0	NA	0	NA	1	16,551
6. Chemical Intermediates	2	309,980	0	NA	0	NA	2	309,980
7. Hydrocarbons	8	701,019	1	27,610	2	493,070	11	1,221,699
8. Distillation Residues	2	1,295,461	0	NA	1	357,944	3	1,653,405
9. Heat Treating Salts	1	16,650	0	NA	0	NA	1	16,650
10. Ink, Ink Solvents	10	733,844	0	NA	1	40,400	11	774,244
11. Lab Wastes	0	NA	0	NA	0	NA	0	NA
12. Metal Wastes	10	1,231,601	0	NA	0	NA	10	1,231,601
13. Paint, Paint Solvents	23	1,543,078	1	40,827	7	483,790	31	2,067,695
14. Paint Strippers	1	26,610	0	NA	0	NA	1	26,610
15. Paper Manufacture	0	NA	0	NA	0	NA	0	NA
16. Pesticide	0	NA	0	NA	0	NA	0	NA
17. Photographic	0	NA	0	NA	0	NA	0	NA
18. Plating	14	661,765	0	NA	2	563,575	16	1,225,340
19. Solvents	31	1,070,056	4	152,535	6	488,658	41	1,711,249
20. Miscellaneous	19	3,302,699	2	173,000	0	NA	21	3,475,699
21. Industrial Formulations	0	NA	0	NA	0	NA	0	NA
22. Polymer Wastes	6	219,078	0	NA	0	NA	6	219,078
Total	180	27,875,166	11	471,563	21	2,564,614	212	30,911,343

NA: Not Applicable in that no waste streams of 15,000 gallons or above are reported.
* See Table 2, Appendix B for detailed data.
Note: Data are only for generated wastes managed off-site.

Source: Franklin Associates, Ltd.

Table 3

LIQUID HAZARDOUS WASTE LAND DISPOSED IN COOK, DU PAGE, AND LAKE COUNTIES*

(1982)

Waste Categories	No. of Streams	Gallons	Percent
Acids	12	239,865	1.10
Alcohols	3	9,456	0.04
Alkaline sludges	22	11,700,337	53.82
Aromatic HC	6	15,849	0.07
Chemical intermediates	0	0	0.00
Hydrocarbons	21	1,649,114	7.52
Distillation residues	5	1,288,756	5.93
Heat treating salts	1	15,000	0.07
Ink, ink solvents	5	43,680	0.20
Metal wastes	15	115,092	0.53
Paint, paint solvents	23	139,909	0.65
Paint, paint stripper streams	3	14,120	0.06
Pesticides	0	0	0.00
Photographics	0	0	0.00
Plating bath sludge	21	437,601	2.01
Solvents	9	131,900	0.61
Miscellaneous	93	5,929,658	27.28
Polymer waste	1	23,624	0.11
Industrial formulations	0	0	0.00
Total	240	21,753,961	100.00

Note: Data are only for generated wastes managed off-site.
* See Table 3, Appendix B for detailed data.
Source: Franklin Associates, Ltd.

which is subsequently disposed of in the facility's "secure" landfill. This quantity was not reported on either a Generator or Facility Annual Report. It has been included for consideration in this study since it is generated from other delivered hazardous wastes and is ultimately disposed of in a commercial hazardous waste landfill.

Waste Type. Five waste categories account for 97 percent of the total quantity land disposed in the three-county area: alkaline sludges, hydrocarbons, distillation residues, plating bath sludges, and miscellaneous. The largest quantity of waste that is land disposed is from the alkaline sludge category, consisting primarily of metal hydroxide sludges from treatment facilities (discussed later).

As previously mentioned, approximately 12.5 million gallons of the total land-disposed wastes are generated within the three-county area. Therefore the remaining 9 million gallons are generated elsewhere and transported into the three-county area.

Comparison of Waste Generation and Waste Disposal in Three-County Area. A comparison of generation versus disposal of liquid hazardous wastes in the three-county area is shown in Table 4. This comparison is not precise because only waste streams of 15,000 gallons or greater are accounted for in the generation column of Table 4. However, all the known land-disposed liquid hazardous waste in the three-county area are shown.

Summary of Comparison. Arranging the three-county waste stream generation (≥15,000 gallons) by waste category identifies 212 waste streams and nearly 31 million gallons. Waste streams land disposed in the three-county area, arranged by waste category, total 240 in number and nearly 22 million gallons.

Several major differences are noted in Table 4 between waste types generated in the area versus those land disposed. Over 7 million gallons of acidic wastes are generated while only about 300,000 gallons are land disposed in the area. Much larger generation than land disposal is also noted for alcohols, chemical intermediates, distillation residues, ink solvents, metal wastes, paint solvents, paint strippers, plating waste, solvents, and polymer waste. Conversely, more land disposal than generation is noted for alkaline wastes (primarily metal hydroxide sludges), hydrocarbon waste, and miscellaneous wastes (large quantities of oily wastes).

Observations from Data Comparison. The preceding comparison leads to some observations pertaining to the differences between generation and disposal in the three-county area.

When generation is greater than disposal, there are several plausible answers:

Table 4

COMPARISON OF LIQUID HAZARD WASTE GENERATION AND LAND DISPOSAL IN COOK, DU PAGE, AND LAKE COUNTIES 1/

(1982)

Waste Categories	Generation 2/		Land Disposal	
	No. of Streams	Gallons	No. of Streams	Gal
Acids	37	7,393,744	12	239
Alcohols	3	165,550	3	9
Aliphatic HC	0	0	0	
Alkalines	17	9,402,248	22	11,700
Aromatic HC	1	16,551	6	15
Chemical intermediates	2	309,980	0	
Hydrocarbons	11	1,221,699	21	1,649
Distillation residues	3	1,653,405	5	1,288
Heat treating salts	1	16,650	1	15
Ink, ink solvents	11	774,244	5	43
Lab wastes	0	0	0	
Metal wastes	10	1,231,601	15	11
Paint, paint solvents	31	2,067,695	23	13
Paint strippers	1	26,610	3	1
Paper manufacture	0	0	0	
Pesticides	0	0	0	
Photographics	0	0	0	
Plating	16	1,225,340	21	43
Solvents	41	1,711,249	9	13
Miscellaneous	21	3,475,699	93	5,92
Industrial formulations	0	0	0	
Polymer wastes	6	219,078	1	2
Total	212	30,911,343	240	21,75

1/ See Tables 2, 3, and 4,Appendix B for detailed data.
2/ Represents only waste streams > 15,000 gallons.
Note: Data are only for generated wastes managed off-site.

Source: Franklin Associates, Ltd.

1) A portion of the waste is reclaimed or used in some useful manner
2) The waste is managed by some means other than land disposal
3) The waste is land disposed outside the three-county area and, therefore, no record is available for this report.

In addition to waste generated in the three-county area being land disposed outside the area, waste generated outside may be disposed of in the area. This is an important point in understanding why land disposal is greater than generation in the three-county area for some waste categories.

When examining the cases where land disposal is greater than generation in the three-county area, the answers are not as evident as before. The waste categories where this was observed are discussed below.

1) Alkalines. Of the 17 waste streams generated and 22 land disposed in the three-county area, only 6 streams are present in both columns. These streams represent 95 percent of the generated waste and 76 percent of the land disposed waste. The 11 generated waste streams not accounted for under land disposal are presumably managed by one of the three methods described previously. Sixteen of the 22 waste streams land disposed in the three-county area were either generated outside the area or were apparently not reported as generated within the area.

2) Hydrocarbons. None of the waste streams reported under land disposal was also reported under generation. Thus, all the hydrocarbon waste generated in the three-county area is presumably managed through the three previously described methods. The land disposed waste is either from outside the area or was not properly reported.* While 21 hydrocarbon waste streams are reported as land disposed in the three-county area, one waste stream known to be

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* Where quantities have been discovered generated within the three-county area, yet no record existed, the appropriate additions have been made to our data tables.

generated outside of the area and state comprises 98 percent of the land disposed waste. This waste category was eliminated from detailed analysis because the industry of concern is considerably outside the Illinois state boundary.

3) Miscellaneous. Of the 21 waste streams generated and 93 land disposed in the three-county area, only 8 are present in both columns. These waste streams represent 47 percent of the generated waste and only 28 percent of the land disposed waste. Based on the difference in the total number of waste streams and the waste quantities, a major portion of the waste land disposed must be generated outside of the area.

It is clear that a large quantity of the waste that is land disposed within the three-county area is not generated within the area. Further, a large portion of the waste generated within the area is not land disposed there.

Industry Cooperation

Except in a few cases where companies have special processes and were concerned about trade secrets, all companies have cooperated and appear willing to examine alternatives in order to reduce hazardous waste. (ENR has agreements with the IEPA, ENR contractors, and individual companies not to release specific information about sites unless permission is granted by the company.)

Discrepancies Between Generator and Facility Annual Reports

When comparing the data from 1982 Generator and Facility Annual Reports, discrepancies were observed. The Generator Annual Reports are filed by firms which generate hazardous waste managed off-site. These reports indicate the amount and type of waste generated from a specific firm. The Facility Annual Reports are filed by firms which accept and treat, dispose, or otherwise manage hazardous waste. These reports indicate the amount of waste handled by a specific facility, the handling method, the generator's name, and sometimes location. Discrepancies were found when the data reported on these two forms were compared. A summary of some of those discrepancies follows:

1) Proper reporting of hazardous waste. It appears that some hazardous waste is not reported as required. For example, a waste reported on a Facility Report may not always be found on a Generator Report and vice-versa. Further, an ENR review of a specific industrial sector (from a Dun and Bradstreet list) suggests that some generators which should fall under RCRA reporting requirements may, in fact, not be reporting.

Another major problem is the inconsistent use of RCRA numbers. Different RCRA numbers are often used for reporting the same waste. (Including the times when no treatment is performed on the waste. In other words, a generator will report the waste under one RCRA number, while the accepting facility will report it under a different RCRA number even if no treatment of the waste occurs.)

2) Discrepancies in reported quantities of waste. Quantities reported on the Generator Reports were sometimes found to be different from quantities in Facility Reports reporting the same firm and waste. Facility Reports which reported values either higher or lower than the corresponding Generator Reports were found. These differences were verified through telephone contacts with selected generators, but usually no explanations for the discrepancies were found.

Inadequacies in Waste Reporting System

The extraction of information from 1982 Annual Reports and an examination of the waste reporting system revealed many shortcomings. A summary of some of those inadequacies follows:

1) Tracking system for hazardous waste. The discrepancies between Generator and Facility Annual Reports, as described in the preceding discussion, illustrate the need for improvement in the tracking system. A "cradle to grave" approach to tracking hazardous waste is considered the norm; however, this concept is almost impossible to carry out. Split waste streams, traffic in and out of the State, different treatment practices at treatment facilities and their resultant waste streams all tend to obscure the facts.

2) Paperwork. The amount of paperwork generated under RCRA and State law is enormous; however, there are few means of readily comparing different forms, combining data, or auditing hazardous waste streams. While performing this study it was found that at least one firm obtained and completed the wrong Annual Report form, which later caused much confusion.

   The timeliness of data availability is also poor, so that the data are of little use in emergencies or in correcting mistakes until several months go by. There also appears to be duplication of effort in some data collected in the Chicago area.

3) Waste identification. RCRA codes (1 alpha and 3 numeric) are ambiguous, overlapping, and confusing. Many wastes in the Annual Reports have four RCRA codes identifying them (IEPA limited the form to four); some wastes could easily be classified under six codes. RCRA numbers are generally of little assistance in determining degrees of hazard. Some wastes which are listed, by virtue of their method of generation, appear to be of extremely low toxicity (if toxic at all). The data on the manifest sheets are also insufficient in describing the wastes. Some companies have considered trying to delist a waste, but cannot afford the necessary effort.

4) Hazardous waste management. In many instances, IEPA records do not provide accurate information as to where a waste is generated because indicated mailing addresses may be the corporate headquarters rather than the generating establishment. This combined with the question of company name results in considerable confusion. Sorting by Zip Code or municipality is difficult to do under the current system. Where the waste ends up is also confusing to determine because: 1) companies have a tendency to utilize more than one management firm in order to keep their options open should one close down or changes its conditions for waste acceptance; and 2) waste treatment facilities may be out of state or may ship their waste (residuals from the treatment process) out of state for further treatment or disposal.

Many of the discrepancies in the Annual Reports and the inadequacies in the waste reporting systems were verified or discovered through telephone contacts.

Changes in Three-County Area Waste Management

Methods of disposal and the amount of hazardous waste generated were significantly different in 1983 when compared with the 1982 Annual Reports. Telephone contacts revealed rapid changes in hazardous waste management in the three-county area.

During telephone and on-site contacts, it was discovered that many companies have instituted changes in the last year which either reduced the amount of waste generated, eliminated the waste stream, or resulted in changed disposal sites. Increasing disposal costs, disposal site requirements for waste acceptance, and fear of changing requirements (disposer and regulator) all have caused changes.

The data aggregated in Phase 1 contain information on 1982 off-site managed wastes. Changes in waste generation or waste management coming after 1982 were taken into consideration during the Phase 2 work, but are not indicated on any tables presenting 1982 waste generation or disposition. Reported 1982 quantities found to be incorrect (for 1982) were changed and the corrected values are presented in the tables.

INDUSTRY/WASTE STREAM SELECTIONS FOR PHASE 2 EVALUATION

Preliminary Selection

As previously indicated, the following three selection criteria were established to select waste streams for evaluation in Phase 2:

1) Quantity of the waste land disposed
2) Hazard potential of the waste
3) Degree of industry cooperation

With the selection criteria in mind, a review of the accumulated generation and management data and consultations with the Illinois ENR resulted in a recommended listing of waste streams and corresponding industrial waste generators for evaluation in Phase 2 (Table 5). These 32 recommended waste streams include wastes from eight of the waste categories. Within these waste streams, 52 land disposed waste quantities are shown--each from a corresponding industrial waste generator.

Some of the industrial establishments corresponding to the waste streams listed in Table 5 are facilities that treat and/or recover waste materials and as a result have residues. Examples of these facilities include those neutralizing acid and alkaline materials as well as those reclaiming solvents and hydrocarbons.

Final Selection

The liquid hazardous waste streams chosen for preliminary evaluation represent those judged to be particularly hazardous and/or those where large quantities are disposed on land in the three-county area. All of the waste streams chosen were disposed of on land in the three-county area in 1982. It was recognized that not all of these waste streams could be evaluated within the scope of this study.

Those waste streams evaluated were chosen based on a priority listing and based, further, upon available information and industry cooperation in providing data. Thus, ten waste streams were chosen for initial emphasis. The ten final choices were made following contacts, by letter and phone, with about 25 of the identified generators of liquid hazardous wastes disposed in the three-county area. These contacts served to verify waste stream characteristics and determine generator cooperation.

Table 5

RECOMMENDED WASTE STREAMS FOR EVALUATION IN PHASE 2

Waste Category	Waste Type	RCRA Number	Quantity Land Disposed in Three-County Area (gallons/year)
Alkaline solution	Dilute caustic sludge	D007, D008	110,400
		D002, D008	45,150
	Filtered metal hydroxide sludge, concentrator sludge	F007, F009	1,415,616
	Metal hydroxide sludge	-	7,272,000
		-	15,147
	Caustic waste water	D002	145,300
		D002	48,100
Distillation residues	Aniline recovery still bottoms (alkaline blue pitch)	K083	746,444
	Distillation and evaporation residues	D002	51,275
	Tar waste	K087	20,652
	Organic solvent distillation residues	D001, F005	-
Ink, ink solvents	Printing ink waste	D007, D008	22,700
	Oil dried resins/ink contaminated sludge	K086	9,090
	Ink solvents	F003, F004, K086	-
	Ink sludge	K086	2,090
Metal waste	Sodium salts/chromium waste/petroleum distillates and solvents	D002, D007, D001	67,900
	Chromium and iron hydroxide sludge	D007	4,500
Paint, paint solvents	Paint waste still bottoms	D006	101,202
		D008	12,900
	Paint booth sludge	D007	12,210
	Paint/resin sludge	D001	10,000
Plating bath sludge	Wastewater treatment sludge from electroplating operation	F006	72,720
		F006	48,892
		F006, F007, F008, F009	-
		D001, D002, D007	-

Table 5 (continued)

Waste Category	Waste Type	RCRA Number	Quantity Land Disposed in Three-County Area (gallons/year)
Plating bath sludge (con't)	Chrome plating sludge	D007, F006, F008	33,323
	Deburring & mechanical plating	D006	54,529
	Copper sulfate/sulfuric acid	F007, D002, D008	968,917
Solvents/Hydrocarbons	Chlorinated solvents & others	F001	12,000
		F002	4,700
		-	-
		-	-
	Hydrocarbons	D001	-
Miscellaneous	Flotation sludge/oil emulsions	K048, K049, K051	791,334
		K048, K051	24,720
	Tank bottom sludges	K052	17,500
	Tank bottom sludges & separator sludge	K051, K052	-
	Baghouse/electric furnace sludge	D006	24,323
		D006	16,157
		K061	9,090
		K061	14,554
		K061	411,247
		K061	1,067,291
	Soluble oils/wastewater	D006, D008	45,550
		D008	21,595
	Oil & water waste	K062, D006, D007, D008	346,800
		K048, K049, K050, K051	74,494
	Tank washing & rinse water	K062	71,500
		D002	107,900
	Concentrator tailing	D008	369,183
	Chemical cleaning solution	D002	104,437
		D008, F001, F002, F003	12,120

Source: Franklin Associates, Ltd.

The ten liquid hazardous waste streams chosen for final evaluation in Phase 2 are as follows:

1) Metal Hydroxide Sludge from Typical Commercial Treatment (RCRA numbers based on presence of heavy metals)

2) Metal Hydroxide Sludge from Extended Lime Treatment (RCRA numbers based on presence of heavy metals)

3) Wastewater Treatment Sludge from Electroplating Operations (RCRA Number F006)

4) Petroleum Refining Sludges (RCRA Numbers K048, K049, K050, K051)

5) Petroleum Distillates and Solvents/Chromium Wastes (RCRA Numbers D001, D007)

6) Aniline Waste from Still Bottoms (RCRA Number K083)

7) Waste Solvents (RCRA Numbers F001, F002, F003, F005)

8) Ink-Related Wastes (RCRA Numbers D007, D008, F003, F004, K086)

9) Concentrator Tailings from Secondary Brass Refining (RCRA Number D008)

10) Emission Control Sludges from Primary Production of Steel (RCRA Number K061).

Some of these waste streams were of concern primarily because of one establishment's generation of the waste. The Number (5) waste stream listed above is actually several wastes from one establishment.

At least one generating establishment was contacted and visited for each of the above-listed waste streams. Two generating establishments were visited for waste streams (1)*, (3), (4), (7), and (8). The site visits were invaluable in obtaining data for use in evaluating waste management alternatives.

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* One of the establishments visited had a proprietary step in their process which produced a delisted waste. The waste stream description (discussed later) concentrates on the firm producing the hazardous waste.

Selection Modifications and Rationale

The ten waste streams chosen for final evaluation are the streams for which detailed analysis and waste management evaluations were performed. The work plan proposed examining the hydrocarbon waste stream, but due to a lack of industry cooperation another waste stream was substituted. The substituted waste stream was baghouse/electric furnace sludge from primary production of steel. If a waste stream of concern to the three-county area could not be properly evaluated by obtaining data from industry within the area, then outside industry cooperation was sought. In two cases data from industries outside of the three-county area were obtained. The information from these contacts was utilized in this study.

SUMMARY OF PHASE 2 WORK PLAN

The Phase 2 effort was conducted in general accordance with the Phase 2 Work Plan discussed previously. Substitutions were arranged for two companies listed in the Work Plan who did not choose to be interviewed and visited. The basic elements of the Phase 2 effort were:

- A literature review to obtain data pertinent to the selected waste stream evaluations
- Contact with the Illinois Manufacturers Association to apprise them of the study and to seek their support
- On-site generator/facility visits to obtain first-hand data to assist in the waste stream evaluations
- Development of waste stream characteristics and industrial process data and flowsheets
- Evaluation of waste management alternatives to land disposal for those waste streams selected for evaluation
- Organization of the information developed in Phases 1 and 2 into a readily accessible format in the report and accompanying appendices.

A brief discussion of the Phase 2 efforts follows.

Literature Review

The first step in the waste stream evaluations was a review of available literature. This review began upon the final selection of waste streams. Where applicable, the literature review provided background material on the generating industry and its processes. It described waste characteristics and the final disposition of the wastes, and identified waste management alternatives. The information obtained in the review was particularly helpful in preparing for on-site visits with the waste generators.

Contact with Illinois Manufacturers Association

Prior to visiting industrial establishments generating the waste streams to be evaluated, a meeting was held with a representative of the Illinois Manufacturers Association. The purpose and objectives of the study were explained and the items below were agreed upon.

1) A press release on the ENR Hazardous Waste Program and the study would be published in the Association's weekly newsletter.

2) The members of the Association's environmental committee would be contacted pertaining to ENR and the study.

3) For companies to be visited in the study, the names of prospective contacts would be provided.

On-Site Generator/Facility Visits

Prior to the on-site visits, each firm was contacted by phone to verify the time and place of the meeting. A confirmation letter and an outline of possible topic areas were also sent to the firms. This outline was developed from a questionnaire* prepared for the on-site interview.

The on-site interviews provided a better understanding of the waste streams** and the processes resulting in those wastes. The major topics addressed during the interviews were the waste stream characteristics, process descriptions, and present waste management practices and alternatives. The waste stream characteristics were developed from average values provided by each firm or from a collection of data from which average values were derived. Process description flowsheets were developed after the waste generating process was described and following a plant and laboratory tour. Knowing a firm's present waste management practices and obtaining their input on management alternatives provided valuable information which aided in the evaluation of alternatives to land disposal.

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* The questionnaire used in the on-site visits is contained in Appendix A.

** As illustrated earlier, the RCRA number designation and the brief description on the Annual Reports does not provide an adequate identification of the waste and its characteristics.

Table 6

TECHNICAL, ECONOMIC, AND REGULATORY CRITERIA FOR THE EVALUATION OF WASTE MANAGEMENT ALTERNATIVES

Technical Criteria

1. Is technology proven in actual commercial use?
2. Are equipment modifications minor or major?
3. Is the quality of the final product affected?
4. Is the quality and consistency of waste stream a problem?
5. Is alternative pollution control required?
6. Is equipment readily available?
7. Are the operating requirements for the equipment consistent with typical industry skill levels?
8. Is the practice applicable to most or only a small segment of industry?

Economic Criteria

1. What are the capital investment and operational costs?
2. What is the effect on remaining waste treatment/disposal costs?
3. Is the process modification applicable to more than one waste stream?
4. Do markets exist for the recovered material?
5. Does the practice influence raw material purchases?
6. Does the size of the facility/waste stream affect economic feasibility?
7. What are the transportation costs to off-site treatment/recovery?
8. What are the overall comparative costs between the alternatives?
9. Is the industry financially capable of the capital investment for process modification or treatment equipment purchase?

Regulatory Criteria

1. Does the practice facilitate regulatory compliance?
2. Does the process modification result in alternative waste streams which are also regulated?
3. Is the use of the recovered material regulated?

Evaluation of Waste Management Alternatives

Evaluation of waste management alternatives was performed on the basis of economic, technical, and regulatory criteria. Factors considered under each set of criteria are shown in Table 6. The waste management alternatives examined included waste reduction methods, treatment methods to detoxify waste, and alternative disposal including incineration.

Three areas were considered under waste reduction:

1) Source separation
2) Process modifications
3) Recovery/recycling.

Alternative treatment methods considered included stabilization/solidification techniques.

Organization of Phase 1 and 2 Information

The results of the study are presented in five volumes: the actual report and four supporting appendices.

The report volume summarizes the findings from Phases 1 and 2. The following information can be obtained in this volume:

1) Summary of hazardous waste generation in the three-county area, arranged by industry groups and waste categories

2) Summary of hazardous waste treatment/disposal in the three-county area, arranged by waste categories

3) Inadequacies in the wastes reporting system and discrepancies observed between 1982 Generator and Facility Annual Reports

4) Summaries of the waste stream evaluations (detailed waste stream evaluations may be found in Appendix A)

5) The waste streams and corresponding waste quantities covered through visits with industrial establishments and those waste streams for which the detailed evaluations are applicable

6) Projections of future land disposal in the three-county area, based on waste management alternatives evaluations and any apparent trends.

Appendix A includes detailed presentations of the waste stream evaluations. Process descriptions and flowsheets identifying waste stream characteristics, and waste management alternatives evaluations are contained in Appendix A. The evaluation of waste management alternatives was based on economic, regulatory, and technical criteria. A sample questionnaire used in on-site visits has also been included in this appendix.

Appendix B contains summary tables and data on waste generation and management in the three-county area. Generation data are arranged by industry group and waste category. Waste management data are arranged by waste category and waste management data also generated in the three-county area are arranged by industry group. Waste streams generated in the three-county area are identified if they are among those examined during plant visits or if they are among those for which detailed evaluations are appliable.

Appendix C contains the computer printout of data obtained from the 1982 Generator Annual Hazardous Waste Reports. The data include hazardous waste generation in the three-county area. The information has been sorted and tabulated for each county in the following ways:

- Waste quantity (in descending order)
- RCRA hazardous waste numbers
- Company name (in alphabetical order).

Appendix D contains the computer printout of data obtained from the 1982 Facility Annual Hazardous Waste Reports. The data include hazardous waste treatment/disposal within the three-county area. This information was first separated into land disposal waste (D81) and other treatment and disposal methods. After the initial separation the information was sorted and tabulated in the same three ways mentioned above.

COMPREHENSIVE ASSESSMENT

The results of the Phase 2 comprehensive assessment are summarized hereafter. The ten detailed waste stream evaluations are each summarized relative to:

- waste stream characteristics
- processes generating the waste(s)
- current waste management practices and costs
- alternative waste management practices and costs.

Prior to the waste stream evaluation summaries, a discussion and accompanying table is presented indicating the total waste stream quantities evaluated and the waste quantities for which the evaluations are applicable. The waste stream quantities are further compared to the quantities generated and land disposed in the three-county area.

DATA PERTAINING TO WASTE STREAM EVALUATIONS

The detailed waste stream evaluations concentrated primarily on wastes known to be land disposed within the three-county area. However, with encouragement from ENR, an evaluation was also performed on solvent recovery operations, from which some wastes are land disposed outside the three-county area. In later discussions pertaining to decreased land disposal, only quantities currently land disposed within the three-county area will be included.

Table 7 is used to illustrate the waste streams and quantities covered in the detailed evaluations. The waste streams are arranged by waste category. All quantities pertaining to waste stream evaluations refer back to column two in this table, and thus refer only to land disposed quantities.

The third column in Table 7 includes those waste streams evaluated through establishment (on-site) visits. Nineteen waste streams and approximately 11.9 million gallons of land disposed wastes were evaluated from these visits.* The total waste quantity evaluated is greater than indicated in Table 7 due to the exclusion of solvent recovery wastes land disposed outside the three-county area.

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* Whereas 10 major waste stream evaluations were undertaken, variations in wastes were observed at establishments (e.g., electroplating establishments) generating the same basic waste stream (e.g., electroplating sludge). Thus, with the 10 major waste streams for which evaluations were undertaken, 19 wastes were examined.

Table 7

COMPARISON OF GENERATED, LAND DISPOSED, AND EVALUATED LIQUID HAZARDOUS WASTE STREAMS (1982)

Waste Categories	Generation 1/		Land Disposal 2/		Waste Streams Evaluated from Establishments Visited 2/		Waste Streams for Which Evaluations are Applicable 2/	
	No. of Streams	Gallons	No. of Streams	Gallons	No. of Streams	Gallons Land Disposed	No. of Streams	Gallons Land Disposed
Acids	37	7,393,744	12	239,865	-	-	-	-
Alcohols	3	165,550	3	9,456	-	-	-	-
Aliphatic HC	0	0	0	0	-	-	-	-
Alkalines	17	9,402,248	22	11,700,337	2	8,687,616	14	9,737,289
Aromatic HC	1	16,551	6	15,849	-	-	-	-
Chemical intermediates	2	309,980	0	0	-	-	-	-
Hydrocarbons	11	1,221,699	21	1,649,114	-	-	-	-
Distillation residues	3	1,653,405	5	1,288,756	3	1,115,627 3/	3	1,216,829
Heat treating salts	1	16,650	1	15,000	-	-	-	-
Ink, Ink solvents	11	774,244	5	43,680	2	22,700 3/	4	33,880
Lab wastes	0	0	0	0	-	-	-	-
Metal wastes	10	1,231,601	15	115,092	3	55,900	4	72,057
Paint, Paint solvents	31	2,067,695	23	139,909	-	-	-	-
Paint strippers	1	26,610	3	14,120	-	-	-	-
Paper manufacture	0	0	0	0	-	-	-	-
Pesticides	0	0	0	0	-	-	-	-
Photographics	0	0	0	0	-	-	-	-
Plating	16	1,225,340	21	437,601	2	106,043	20	404,601
Solvents	41	1,711,249	9	131,900	2	12,000 3/	3	28,700
Miscellaneous	21	3,475,699	93	5,929,658	5	1,933,119	20	3,350,349
Industrial formulations	0	0	0	0	-	-	-	-
Polymer wastes	6	219,078	1	23,624	-	-	-	-
Total	212	30,911,343	240	21,753,961	19	11,933,005	68	14,843,705

1/ Represents only waste streams > 15,000 gallons generated within the three-county area.

2/ Represents waste land disposed in the three-county area.

3/ The actual waste quantity evaluated excedes the recorded value for these waste streams. Only those quantities of waste land disposed in the three-county area are indicated. Some generated wastes which are land disposed outside the area were also examined, but the quantities are unknown. However, the indicated number of waste streams evaluated includes those land disposed outside the three-county area.

Note: Data are only for generated wastes managed off-site.

Source: Franklin Associates, Ltd.

The fourth column in Table 7 lists the number of waste streams and waste quantities of which the detailed waste stream evaluations are considered applicable. A total of 68 waste streams and 14.8 million gallons of land disposed wastes are included in this column. Three factors were considered in determining those waste streams for which the waste stream evaluations were applicable. They included: waste category or type of waste (RCRA number); quantity; and location of waste generation. Where these three factors corresponded to a detailed waste stream evaluation then the waste was included in the fourth column of Table 7.

Three-county area waste generators whose wastes or also land disposed within the area are presented in Table 4, Appendix B. In this table the firms visited and the waste streams for which detailed evaluations are applicable are indicated. It can be seen that not all 68 streams indicated in Table 7 are identified in Table 4, Appendix B. This fact can be explained because many of the waste streams for which the evaluations are applicable may not be generated within the three-county area.

SUMMARIES OF WASTE STREAM EVALUATIONS

The following sections summarize the results of the ten waste stream evaluations performed in the study. Each section summarizes information developed on a specific waste stream including waste characteristics, the processes generating the waste stream, and a comparison of waste management alternatives applicable to the waste stream. Each of the waste streams evaluated are either currently being land disposed or were reportedly land disposed in 1982.

In addition to the summaries of the waste stream evaluations which follow, detailed discussions and presentations of information developed during the evaluations are contained in Appendix A.

Section 1: Metal Hydroxide Sludge from Typical Commercial Treatment

A metal hydroxide sludge from a commercial treatment facility was evaluated in this study. This sludge is typical of that generated in facilities treating wastes with heavy metals. The sludge results from the treatment of a variety of wastes including pickle liquors, spent acids, rinse waters, electroplating sludges, paint wastes, detergents, brine solutions, and some oily wastes and solvent material.

Characteristics of Metal Hydroxide Sludge. This sludge is classified as hazardous waste due to its heavy metal constituents. Sludge leachate samples contain both cadmium and mercury at levels beyond the allowable EP toxicity limits.

Metals commonly present in the sludge include arsenic, barium, cadmium ($\sim$440 ppm), chromium ($\sim$70 ppm of Cr VI), lead, mercury (>10 ppm), silver, and selenium. The total organic content of the sludge is typically less than 5 percent and consists primarily of oil and grease. The total solids content of this waste material is somewhat variable, but the average is about 30 percent. One cubic yard of the sludge weighs approximately one ton.

Treatment Process Generating Metal Hydroxide Sludge. Figure 1-1 illustrates a typical treatment process which would generate metal hydroxide sludge. In such a process, acidic and alkaline wastes are received in separate storage areas. These wastes are then combined in a primary settling tank where initial neutralization and settling occur. The effluent from the primary settling tank enters a large mix tank to reduce the impact of fluctuations in feedstream properties. Next, chemicals an polymers are added in a multi-stage chemical treatment unit to precipitate heavy metals.

Wastes from the chemical treatment unit enter clarifiers (secondary settling tanks) where the metal hydroxides and other solids settle to the bottom of the clarifiers and are pumped to a holding pit. The upper level effluent from the clarifier is discharged into the sanitary sewers. The sludge in the holding pit has a 1 to 2 percent solids concentration. This material is periodically batch loaded into a sludge concentrator where additional solids concentration occurs. The sludge leaving the concentrator is expected to be at 6 to 8 percent solids concentration. Additional polymer is added and the material enters a filter press where the final sludge product is generated at about 30 percent solids concentration. Effluent from both the filter press and concentrator are sent back through the system for reprocessing. In total, the solids in the incoming wastes are reported to remain in the treatment system less than two days prior to their removal in sludge form.

Assuming a rate of 100 cubic yards per month of incoming waste, it is observed that nearly 75 cubic yards are acidic wastes and 25 cubic yards are alkaline wastes. Of the 100 cubic yards of incoming waste, approximately 7.3 cubic yards are land disposed.

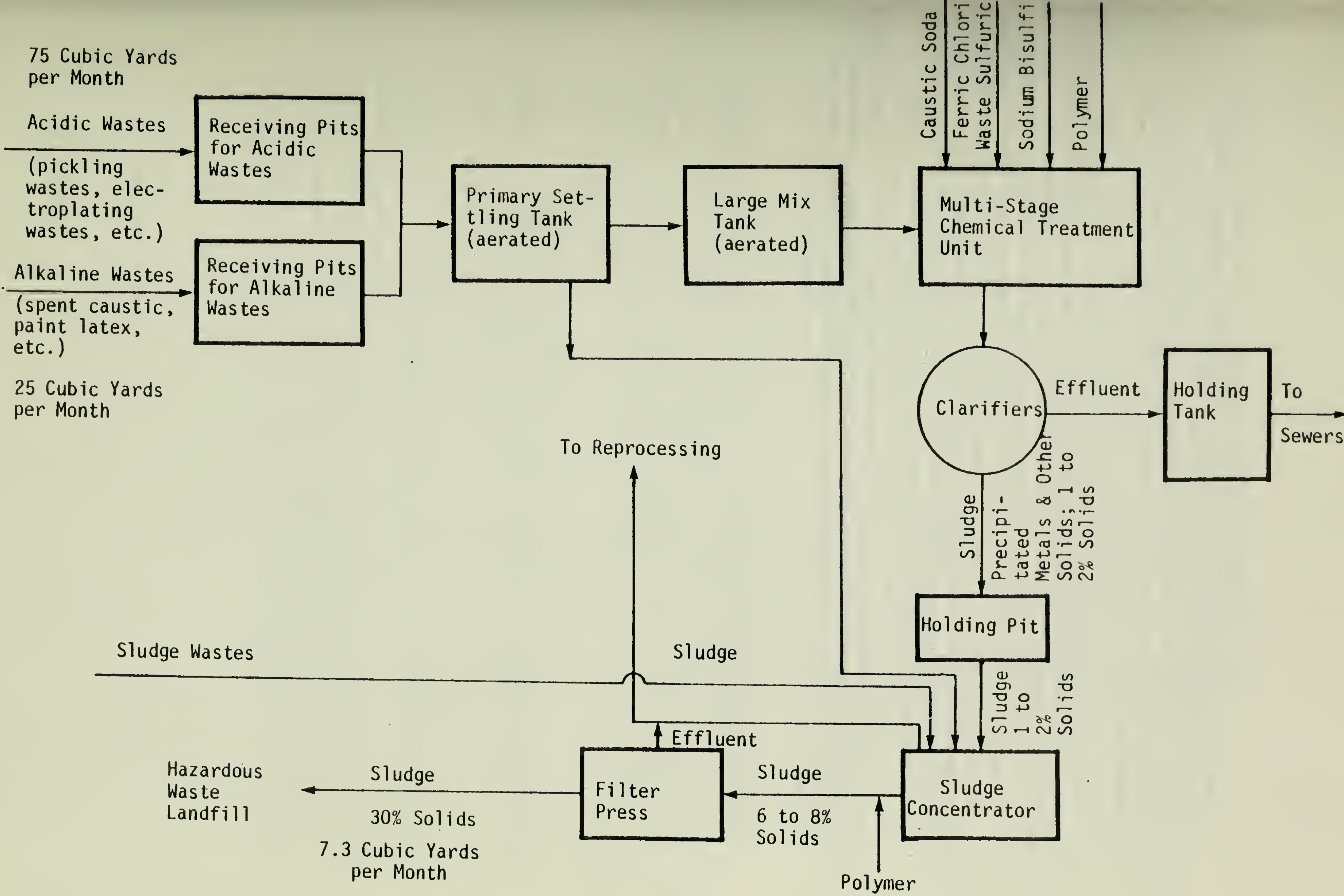


Figure 1-1. Flow diagram of typical treatment process generating metal hydroxide sludge. Basis: 100 cubic yards per month of total incoming waste.

Waste Management Practices and Costs. The metal hydroxide sludge from a process similar to that described above is currently being disposed of in a landfill for a reported price of $28.00 per cubic yard. In addition, the generator must pay about $2.00 per cubic yard to the State of Illinois, and transportation charges are approximately 25 to 50 cents per ton-mile.

Alternatives to landfilling the waste metal hydroxide sludge include various stabilization/solidification methods, incineration, additional filteration to remove water and recovery of heavy metals. The cost of on-site stabilization/solidification followed by land disposal of the treated product is estimated at $28 to $34 per ton for quantities approaching 100,000 gallons per month or greater. This is competitive with current costs for disposing of the sludge in a hazardous waste landfill. Incineration costs are estimated to be in excess of $350 per cubic yard. The costs of additional filteration and heavy metal recovery are also expected to be very high.

A detailed analysis and summary comparison of the potential waste management alternatives for this waste stream is presented in Appendix A-1. The summary table shows comparison of the waste management alternatives based on technical, economical, and regulatory criteria.

Section 2: Metal Hydroxide Sludge from Extended Lime Treatment

The metal hydroxide sludge described in this section is different from the waste discussed in Section 1 for three reasons--the treatment process which generates this sludge is based on the use of lime instead of caustic soda; the sludge produced is concentrated to a solids content of approximately 50 percent, much greater than that reported in Section 1; and the proponents of the treatment process are actively seeking a hazardous waste delisting for the sludge based on EP toxicity test results, whereas the sludge discussed in Section 1 is clearly hazardous based on EP toxicity test results.

One facility which generates this type of metal hydroxide sludge was visited to collect waste generation and disposal information. The wastes accepted at that facility were very similar to those described in the typical treatment operation described in Section 1. However, the extended lime process accepts much higher metal concentrations in incoming liquors, e.g., 200,000 versus 300 ppm Cd and 100 versus 1 ppm Hg. Organic compounds are also permitted at high levels in the wastes as 50 percent for some incoming wastes.

Characteristics of Metal Hydroxide Sludge from Extended Lime Treatment. A chemical analysis of the metal hydroxide sludge discussed in this section is not available. However, the hazardous constituents in this sludge are expected to be similar to those noted in the metal hydroxide sludge described in Section 1 (heavy metals, organic chemicals, and oil and grease). Differences between this sludge and that described previously in Section 1 include a higher solids content--approximately 50 percent, a much higher lime content, and a potentially higher percentage of organic chemicals and oil and grease.

Extended Lime Treatment Processes which Generate Metal Hydroxide Sludge. Figure 2-1 illustrates the two treatment processes resulting in the metal hydroxide sludge discussed in this section. The treatment processes are an acid neutralization process and a dewatering process.

Highly acidic wastes, acidic wastes with high concentrations of contaminants, and metal hydroxide wastes are placed in the acid neutralization process. These incoming wastes are received in acid retention ponds which are maintained at a 10 to 15 percent acidity level. The wastes are pumped from the retention ponds into an adjacent pug mill where lime, probably quicklime (CaO), is introduced. Mixing occurs in the pug mill, and 7 to 10 percent more lime than that needed for neutralization is added. The hydroxide ion of the hydrated lime, which has formed from the reaction of quicklime with water, reacts with heavy metals in the wastes forming insoluble metal hydroxides.

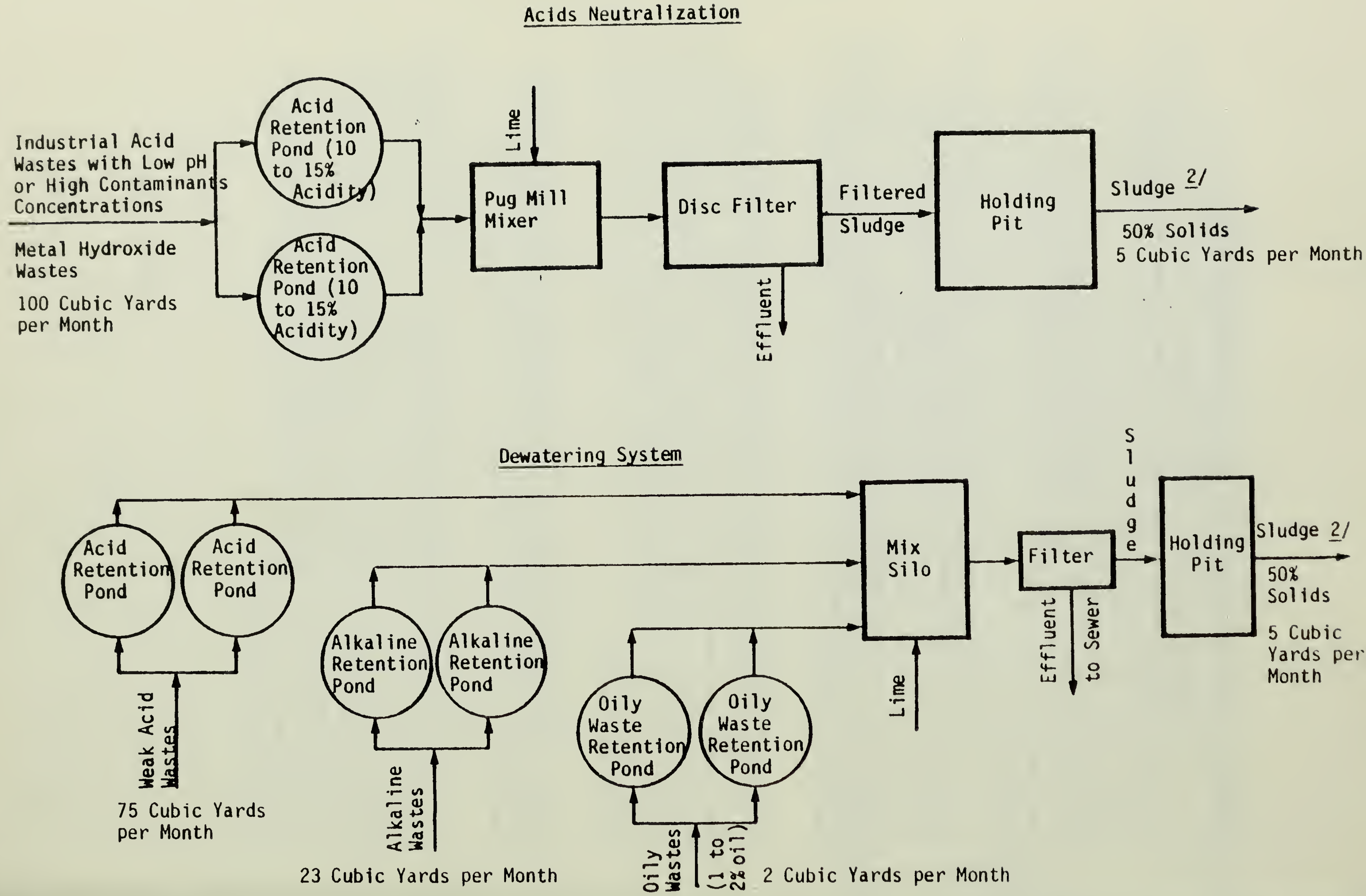


Figure 2-1. General flow diagram of dual process treatment facility generating metal hydroxide sludges. 1/
Basis: 100 cubic yards per month of total incoming waste for each system.

1/ The processes shown here are based upon information obtained

The soup-like pug mill mixture is filtered and the sludge from the filter is placed in a holding area prior to landfilling. The sludge continues to dry for a few hours and is termed an "inert solid" when landfilled. Assuming a rate of 100 cubic yards per month of waste into the acid neutralization process, it is observed that 5 cubic yards are eventually land disposed.

Weak acids, alkaline materials, and oily wastes are placed in the dewatering process. Wastes are received in either acid retention ponds, alkaline receiving ponds, or oily waste receiving ponds. All three storage areas feed into a silo where the wastes are mixed with lime, and possibly a polymer, to form numerous insoluble solids. The resulting slurry is filtered to remove the metal hydroxide and other solids precipitate. The water effluent from the dewatering system is discharged to the sanitary sewer system. The sludge is held in a holding pit and then landfilled. Assuming a rate of 100 cubic yards per month of waste into the dewatering process, it is observed that nearly 75 cubic yards are weak acid wastes, 23 cubic yards are alkaline wastes, and 2 cubic yards are oily wastes. Of the 100 cubic yards of incoming waste approximately 5 cubic yards are land disposed.

Although the sludges from the dewatering system and the acid neutralization have been treated as essentially the same in this section, some differences would probably exist. The dewatering system sludge would be expected to have a higher moisture content unless additional lime is used in this process. Also, the input of oily wastes may result in a higher organic concentration in the sludge from the dewatering system.

Waste Management Practices and Costs. The metal hydroxide sludge described in this section is currently landfilled in so-called "hazardous trenches," which are permitted to accept hazardous materials. The cost for disposal in the trenches is reported to be $30.00 per cubic yard. Since the landfilling procedure occurs near the facility generating the sludge, the cost of collection and transportation is expected to be very low in comparison to the disposal cost.

The facility currently generating this waste is requesting that the sludge be "delisted" or removed from the list of hazardous wastes. They contend that the waste meets the requirements of the EP toxicity test and should, therefore, be considered nonhazardous. If this request is granted, the waste may be disposed of in a nonsecure landfill along with municipal solid waste. The landfilling cost for the sludge would thereby be reduced from $30.00 to $7.00 per cubic yard.

Should attempts to "delist" the lime treated sludge fail, it is anticipated that one of the stabilization/solidification techniques discussed previously could be used on the sludge. The constituents of the wastes being treated which result in this sludge are believed similar to those resulting in other metal hydroxide sludges. The costs for stabilization/solidification, as shown previously, are believed applicable to this sludge and should be competitive with hazardous waste landfill.

A summary comparison of potential waste management alternatives for metal hydroxide sludges generated by extended lime treatment processes is presented in Appendix A-2.

Section 3: Wastewater Treatment Sludge from Electroplating Operations

Electroplating shops generate a variety of wastewaters; and the treatment of these wastewaters results in the formation of sludges. Depending on the nature of a given process, these wastes may be contaminated with a wide assortment of hazardous constituents including heavy metals and cyanides. Two establishments were visited in the course of the study to collect information on waste generation and disposal. A typical production rate for these establishments is approximately 4,000 square yards per day of plated product.

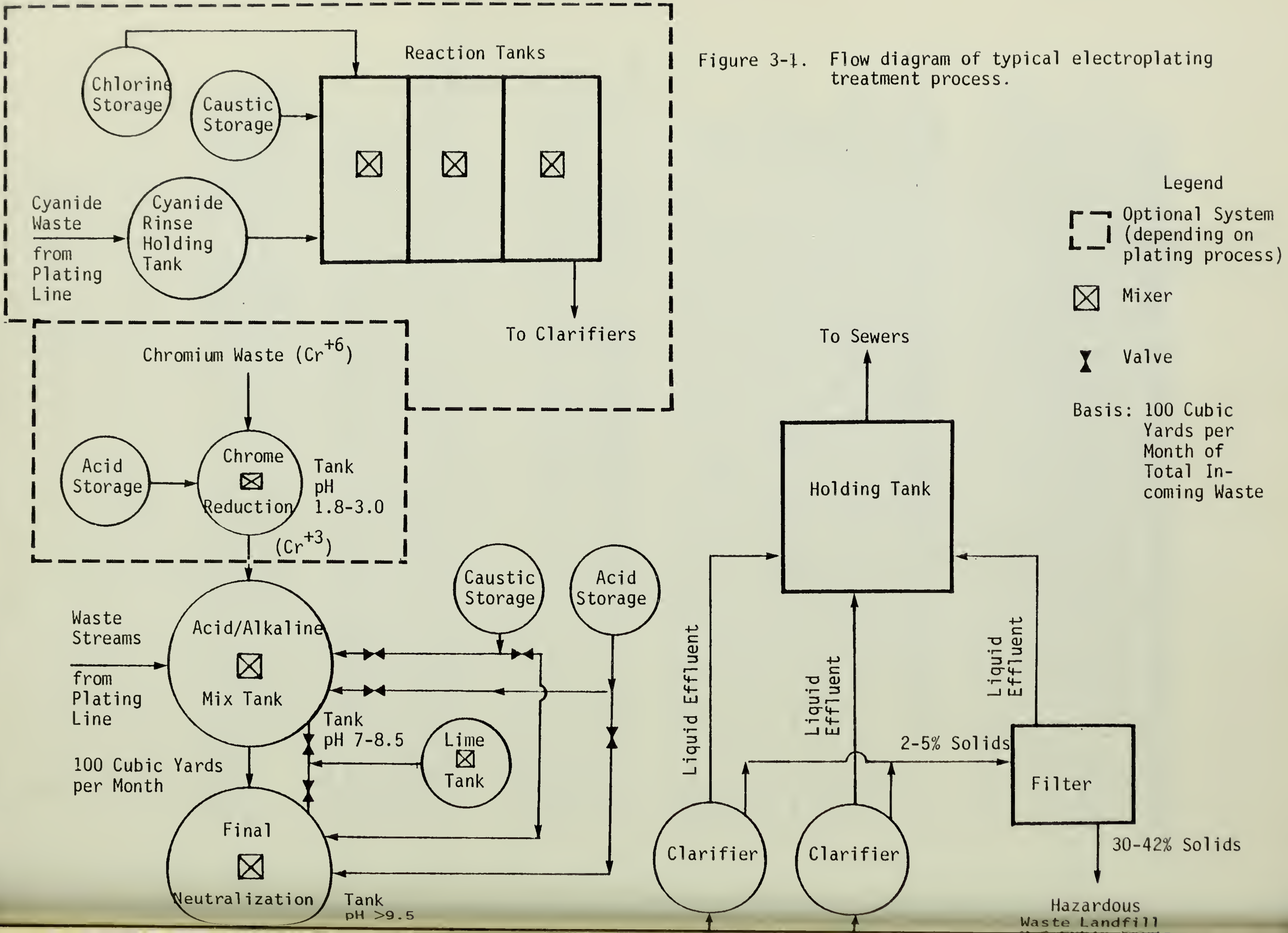
Characteristics of Electroplating Sludges. Different sludges were generated from each establishment visited. The first had a pH range of 9.5-10.0, a density of 9.8 pounds per gallon, a metal content of 12.0 percent, and a total solids content of 30.0 percent. The six most prevalent metals were iron (55,200 ppm), zinc (40,800 ppm), cadmium (9,600 ppm), nickel (6,480 ppm), chromium (III) (4,440 ppm), and copper (1,200 ppm). The second sludge had a pH of 8.2, a density of 11.3 pounds per gallon, a metal content of 6.2 percent, and a total solids content of 42.1 percent. The five most prevalent metals were copper (23,700 ppm), nickel (19,500 ppm), total chromium (10,100 ppm), zinc (4,600 ppm), and lead (3,400 ppm). These wastes are classified as hazardous because of the metals they contain, notably cadmium, chromium, copper, iron, lead, and zinc. Sludges from other plating operations could include other metals or these same metals in different proportions.

Process Generating Electroplating Sludges. Electroplating involves three key steps: pretreatment, electroplating, and post-treatment. Pretreatment prepares the workpiece surface for plating. Cleaning, degreasing, and etching are three examples of pretreatment. The electroplating step involves the application of the desired metal onto the workpiece. The post-treatment step involves rinsing the plated workpiece and the application of any additional coating.

In transferring the workpiece from tank to tank, chemicals, solution, and other contaminants from the preceding tank are carried along. Consequently, rinsing and cleaning wastestreams are frequently contaimanted to such an extent that they may not be disposed of in the sewer. The volume of waste production per square yard of product electroplated ranges between 0.04 gallon per square yard and 0.07 gallon per sqyare yard in those plants visited. Some in-house treatment of these waste streams must first be performed, and electroplating sludge is generated.

A typical treatment process for an electroplater is shown in Figure 3-1. The neutralization and precipitation of contaminants from the rinse water are the major objectives in an electroplating treatment process. The neutralization and precipitation are performed in two tanks. The pH in the second tank is kept between 9.5 and 11.0. (It is generally agreed that

Figure 3-1. Flow diagram of typical electroplating treatment process.



metals will precipitate out of solution within this pH range.) Metals precipitate out in the form of metal hydroxides. Lime and coagulant aids are used to help in sedimentation and concentration of the precipitate.

The liquid effluent stream from the second tank flows to a clarifying system with a solids content of 1 to 2 percent. The clarifiers further concentrate the waste to between 2 and 5 percent solids. This slurry is pumped to a filtering system where it is dewatered to a sludge with 30 to 42 percent solids content. Liquid effluent from both the clarifier and filter is pumped to a holding tank for testing before it is discharged into the sewer.

Two optional systems are also depicted in Figure 3-1 for cyanide destruction and chromium reduction. Cyanide and/or chromium waste are the major toxic contaminants needing special pretreatment. Some electroplating processes may not have these wastes and the corresponding pretreatment will not be needed.

The most economical, simple, and relaible process for complete cyanide destruction (oxidation) is by alkaline chlorination. Cyanide waste from the plating line is sent through a series of reaction tanks where complete destruction occurs with the reaction of cyanides, hypochlorite (OCI-), and hydroxide.

The treatment or removal of hexavalent chromium from such waste streams has been achieved through various methods. The most common method is reduction to the trivalent state in an acid medium and subsequent precipitation and removal of the hydroxide.

Alkaline liquors from cyanide oxidation and acidic liquors from chromium reduction are then mixed, and some precipitation of solids occurs. Lime or other caustic material is then added to cause further precipitation of metal hydroxides. Filtration and clarification stages follow and result in the collection of the sludges already described.

For every 100 cubic yards of total incoming wastes entering the in-house electroplating treatment process, approximately 0.4 cubic yard of electroplating sludge is land disposed.

Waste Management Practices and Cost. The electroplating sludge from the wastewater treatment processes described here is curently being disposed of in secure landfills at a price range of $43.50 to $49.30 per cubic yard including collection and transportation costs. One cubic yard of sludge is assumed to weigh approximately one ton.

Waste management alternatives examined for the electroplating waste were metal recovery techniques, stabilization/solidification, incineration, in-house process changes, and process substitution. Of these alternatives metal recovery from the wastewater streams appears to have the greatest potential for implementation. In considering the feasibility of metal recovery techniques, the rinse water flow rate and the specific metals present play an important role. Using typical wastewater flow rates of 4 to 7 gallons per minute and metal concentrations of approximately 0.5 ounce per gallon, the following recovery techniques appear economically favorable: vapor recompression, electrodialysis, reverse osmosis, and coupled transport liquid membrane. The evaluation of these four systems indicated a savings when recovering a specific metal or metal solution.

A summary comparison of the potential waste management alternatives for electroplating sludge from plating operations is discussed in greater detail in Appendix A-3.

Section 4: Petroleum Refining Sludges

The research on petroleum refining sludges provides an overview of the waste streams generated in refinery operations, and addresses specific waste streams which are classified as hazardous wastes and generally end up in a hazardous waste landfill. Information was obtained from visits to two Chicago area refineries, contact with people knowledgeable in refinery waste disposal, review of pertinent literature, and Facility and Generator Reports from the State of Illinois.

Characteristics of Petroleum Refining Sludges. The Generator Reports for refiners in the three-county area listed the following types of wastes: styrene, solvents, corrosive solids, acids, caustic, API separator sludge, still bottoms, oil, flammable liquids, dissolved air flotation (DAF) sludges, etc. These waste streams which are considered hazardous by the U.S. Environmental Protection Agency are: (1) API separator sludge; (2) DAF sludge; (3) primary oil/solids/water separator sludge; (4) secondary ore/solids/water separator sludge; (5) slop oil emulsion solids; (6) heat exchanger bundle cleaning sludge; and (7) leaded tank bottoms. The constituents which cause these streams to be listed as hazardous are either hexavalent chromium or lead, or the presence of both hexavalent chromium and lead. These elements fail to meet the EP toxicity test if leached at concentrations of 5 mg/l or higher.

Process Generating Refinery Sludges. The type and quantity of sludges generated in refinery operations are dependent on crude oil throughput, crude oil composition, refinery complexity, and the waste treatment methods used. Figure 4-1 shows a general flow diagram for refinery waste treatment/disposal. The process areas would include distillation, hydrotreating, reforming, alkylation, isomerization, hydroforming, fluid catcracking, etc., depending on refinery complexity. Process sludges and oily process wastes come from the process areas. Some sludges may go through little or no treatment. The oily process wastes are usually sent to the API separator, DAF, activated sludge, etc., depending on the level of treatment available at the refinery, and the extent that outside waste contractors are utilized. Therefore hazardous waste sludges can come directly from the process area, or from the refinery waste treatment facility.

The total amount of refining and petroleum wastes generated in the three-county area was 777,902 gallons (Appendix B). The total gallons of hazardous wastes landfiled in the area was 1,166,190 gallons (Appendix B). The data indicate that most of the hazardous wastes landfilled in the three-county area came from plants operating outside the area.

Waste Management Practices and Cost. During the study two area refineries were visited. One refinery uses incineration and landfill to dispose of its hazardous waste. The cost for landfill was $75 per cubic yard (including collection and transportation), which converts to 37 cents per gallon or $89 per ton of waste. Landfill cost for nonhazardous waste

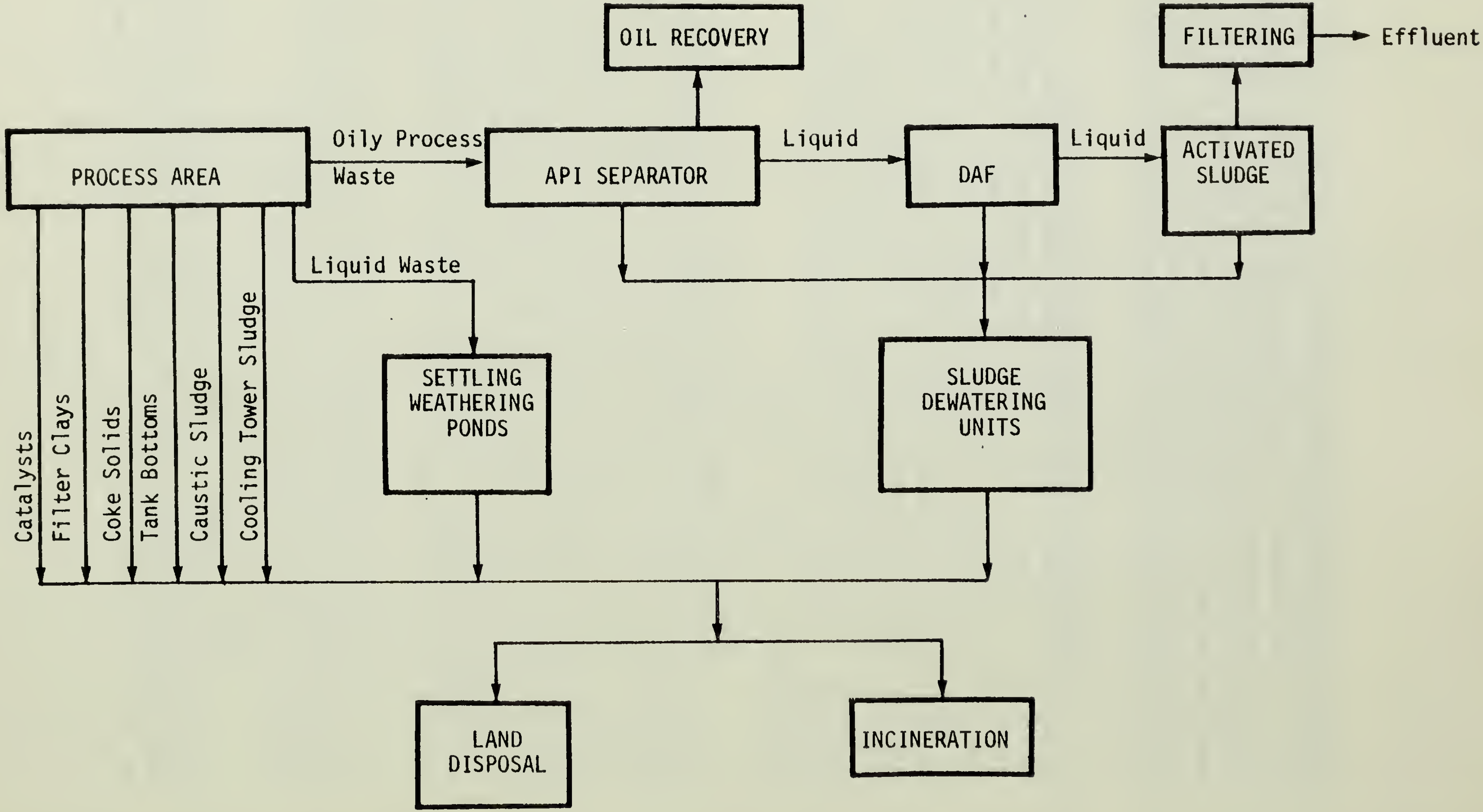


Figure 4-1. General flow diagram for refinery waste treatment/disposal.

was $7 per cubic yard, or less than one-fifth the cost for landfilling hazardous waste. The second refinery visited is currently using waste management contractors to dispose of their hazardous waste. Their costs are between 9 cents and 18 cents per gallon (around $20 to $40 per ton) to have the material hauled away.

Waste Management Alternatives. Waste management alternatives available to the refineries include: process modifications, source separation, improved treatment efficiency, recovery/recycle, and alternative technologies (which include chemical treatment, biological treatment, and thermal processing). The cost to implement these alternatives would generally be site-specific. Adequate information was not available to assign accurate cost values to the alternatives. However, the thermal processes which are available and being developed have great potential for reducing the volume of refinery hazardous wastes which are landfilled. In general the thermal processes will cost from two to five times as much as land disposal. These cost estimates are based on the final cost to dispose of the materials. A detailed systems approach for tracing and allocating costs might prove revealing. This approach would start at the manufacturing process and continue through all of the plant processes, in an effort to assign costs for each material, process, treatment method, etc. The use of thermal methods may eliminate the need for some costly down stream treatment facilities. Disposal costs should be based on the cost per unit of product produced, rather than the cost per unit of waste disposed of.

Section 5: Chromate Contaminated Washwater, Chromium Sludge, and Miscellaneo Petroleum Distillates and Solvents

Chromate contaminated washwater, chromium sludge, and miscellaneous petroleum distillates and solvents generated by an industrial chemical producer were evaluated in this study. Typical data for the generation of these three waste streams was obtained through one establishment.

Characteristics of Waste. The hazardous waste results from general housekeeping procedures and from off-specification products. Constituents of these waste streams account for their classification of hazardous.

The heavy metal content of the chromate washwater explains its classification. Chromium and zinc are the major metals of concern present in concentrations of 18,600 ppm and 4,000 ppm respectively. Chromium and zinc are again the metals of concern in the chromium sludge, present in concentrations of 80,000-100,000 ppm and 15,000-20,000 ppm respectively. Problems posed by oil and grease, starch, and sodium carbonate must also be considered in this waste stream. The miscellaneous petroleum distillates and solvents are hazardous due to the low flash point of the waste. The organic composition in this waste stream is (on the average) greater than 40 percent. The waste consists of aged or off-specification products and, thus, the constituents and their composition vary greatly.

Process Which Generated Chromium Wastes. The chromate washwater and chromium sludge are the only process related waste streams. Raw materials are first mixed with binders and proprietary materials. The resulting product is sent to a formation machine where the product is shaped into the desirable form. From the formation process the product is sent by conveyor to packaging. Note Figure 5-1 for a diagram of this process.

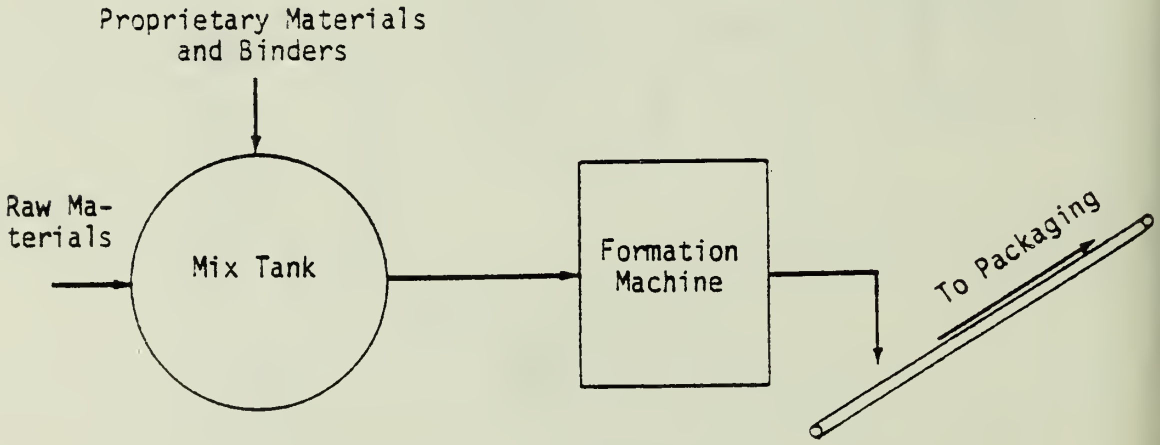


Figure 5-1. Process flow diagram for chromium product.

Air containing process dust and other contaminants are vented to a baghouse filtering system. The filter media is periodically cleaned and the filtered solids are collected in drums. The solids removed from the media comprise a portion of the chromium sludge. The remaining portion of the chromium sludge comes from cleaning beneath the process units.

In the preceding process description, the process line is not used solely for the production of products containing chromium. Thus, periodic cleaning/washing of the process units is necessary. Chromium removal is the major objective in the washing procedure and results in contaminated washwater. This is the only waste stream stored in bulk form.

The generator of all three waste streams utilizes batch formulating processes. The usual packaging of products is in 1, 5, 35, or 55 gallon drum containers. It is in these forms that the aged of off-specification products are observed. The rates of waste generation per amount of product was not made available during this study.

Waste Management Alternatives and Comparative Costs. The chromate contaminated washwater is first treated and then either landfilled or deep-well injected at a cost range between $0.15 per gallon and $0.22 per gallon including collection and transportation. The chromium sludge is landfilled for a corresponding cost of $1.67 per gallon. The miscellaneous petroleum distillates and solvents are reformulated into new products whenever possible. However, if there is insufficient recoverable material then the waste is landfilled at a cost of $0.836 per gallon including collection and transportation.

Alternatives to landfilling the chromate washwater and chromium sludge include sending the waste stream to a treatment facility which generates a nonhazardous waste. The cost of this treatment including collection and transportation of the waste, would be 22.7¢ to 25.7¢ per gallon of washwater and $1.52 to $2.60 per gallon of sludge. Incineration is a plausible alternative for chromium sludge and the petroleum distillates and solvents. The incineration economics appear more favorable for the distillate and solvent stream ranging between $1.00 to $1.50 per gallon while being greater than $1.80 per gallon for the sludge.

A detailed analysis and summary comparison of the potential waste management alternatives for these three waste streams are presented in Appendix A-5. A summary table shows comparison of the waste management alternatives based on technical, economic, and regulatory criteria.

Section 6: Waste Aniline Recovery Blue Pitch

Aniline recovery blue pitch, generated from the manufacture of alkali blue pigment, was evaluated in this study. Only two facilities in the United States generate waste aniline recovery blue pitch; the one located in Illinois was visited. Because of the confidentiality claims by the Illinois facility, the available information for the production of this waste is limited in scope.

Characteristics of the Aniline Recovery Blue Pitch. The exact process generating this waste is not known. However, it appears that this waste is a residual from the recovery, by distillation, of unused aniline from the manufacture of alkali blue pigment. The primary constituent of the waste aniline recovery blue putch is aniline. This waste contains no sulfur or chloride and is a solid at room temperature. The heat content of this waste is approximately 14,000 Btu per pound. The waste can be mixed, when hot, in fuel oil.

Process Generating Aniline Recovery Blue Pitch. Alkali blue pigment is produced by phenylation of p-rosaniline. The phenylation is carried out by adding required quantities of aniline, rosaniline, and benzoic acid to the reactor and by heating to complete phenylation. After the phenylation reaction is complete, the mixture is added to excess hydrochloric acid to precipitate (spirit-soluble) aniline blue. The aniline blue is then sulfonated, followed by washing, neutralization, and evaporation to make alkali blue pigment powder. Note Figure 6-1 for a diagram of this process.

Information is not available in the literature on the waste generation rate per unit of production. The Illinois facility generating this waste considered this information as confidential and, hence, no data are available on the waste generation rate. However, the Illinois facility generated approximately 3.2 million pounds of waste aniline recovery blue pitch in 1982.

Waste Management Alternatives and Costs. The Illinois generator is currently disposing of the waste aniline recovery blue pitch in an off-site secure landfill at a cost of $36 per ton, including transportation. However, the producer is in the process of securing permits to burn this waste in on-site boilers. It is likely that by the end of 1984, the Illinois facility will burn this waste in either on-site boilers, off-site incinerators, or other high temperature processes as secondary fuel.

Burning in an incinerator is expected to cost $50 per ton, since this waste has a high net heating value. Burning in on-site boilers as secondary fuel will generate an estimated revenue of $99 per ton, while burning in off-site boilers is expected to generate only $50 per ton because of the transportation costs. Burning in other high temperature off-site processes should also generate approximately $50 per ton.

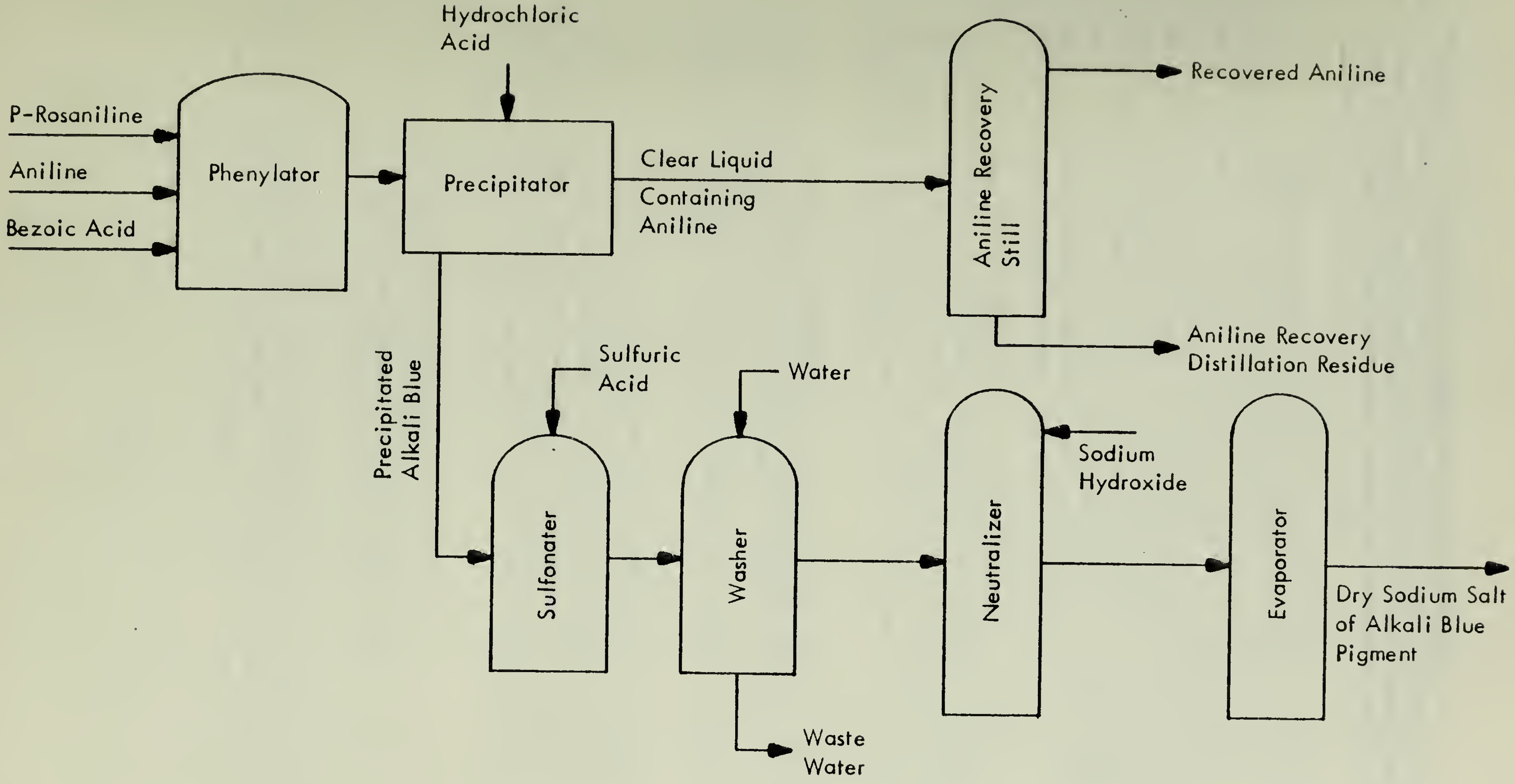


Figure 6-1. Alkali blue pigment manufacturing process.

A detailed analysis and summary comparison of the potential waste management alternatives for the waste aniline recovery blue pitch is presented in Appendix A-6. The table shows comparison of management alternatives based on technical, economic, and regulatory criteria.

Section 7: Wastes from Solvent Recovery Operations

Waste streams from two solvent recovery operations were evaluated. Only one of these facilities handles halogenated material. Both process a wide variety of non-halogenated solvents.

Characteristics of Solvent Recovery Wastes. Solvent recovery operations generate three wastes--wastewater, distillation residue, and filtered solids. Wastewater results from the removal of water from the waste solvent. This waste stream is commonly contaminated with small quantities of the solvent with which it has been in contact (i.e., toluene, methanol, isopropyl alcohol, acetone, methyl ethyl ketone, mineral spirits, xylene, or halogenated organics) and trace amounts of toxic metals. The distillation residue is sold as a secondary fuel. The filtered solids consist of moisture, dirt, inorganic compounds, and toxic metals. Cadmium and lead were the primary leachable metals contained in the filter cake of one facility where leaching tests had been performed.

Some solid wastes and semisolid sludges are also generated in the course of plant and equipment maintenance procedures. However, the management of these wastes (including distillation residues) is not discussed in any detail in this section or in Appendix A-7, because these wastes are incorporated into secondary fuel supplies and burned, and they are not subject to any form of land disposal.

Processes Generating Solvent Recovery Wastes. Wastewater is generated by the removal of aqueous fractions from waste solvent settling tanks or by other water separation processes, such as the use of resin beds. Solids accumulate as filter cake during associated wastewater treatment. Figure 7-1 presents a generalized diagram of solvent recovery processes for non-halogenated hydrocarbon solvents.

The rate of waste generation at one of the facilities visited is as follows for each of the 100 gallons shipped to customers, 27 gallons is lost and the remaining 73 gallons of solvent is shipped back to a waste solvent recovery facility. All of this waste solvent and 34 gallons of virgin solvent are required to produce 100 gallons of solvent suitable for return to the customer's plant. The 7 gallons of waste solvent which are not returned consist of:

6.0 gallons of distillation residues,
0.5 gallon of wastewater,
0.4 gallon of solvent which is resold, and
0.1 gallon of dewatered filter cake.

In the recovery of halogenated solvents, the primary settling operation is eliminated, since traditionally halogenated waste solvents do not contain water and sediment. As a result, the only waste generated in the recovery of halogenated solvents is the distillation residue.

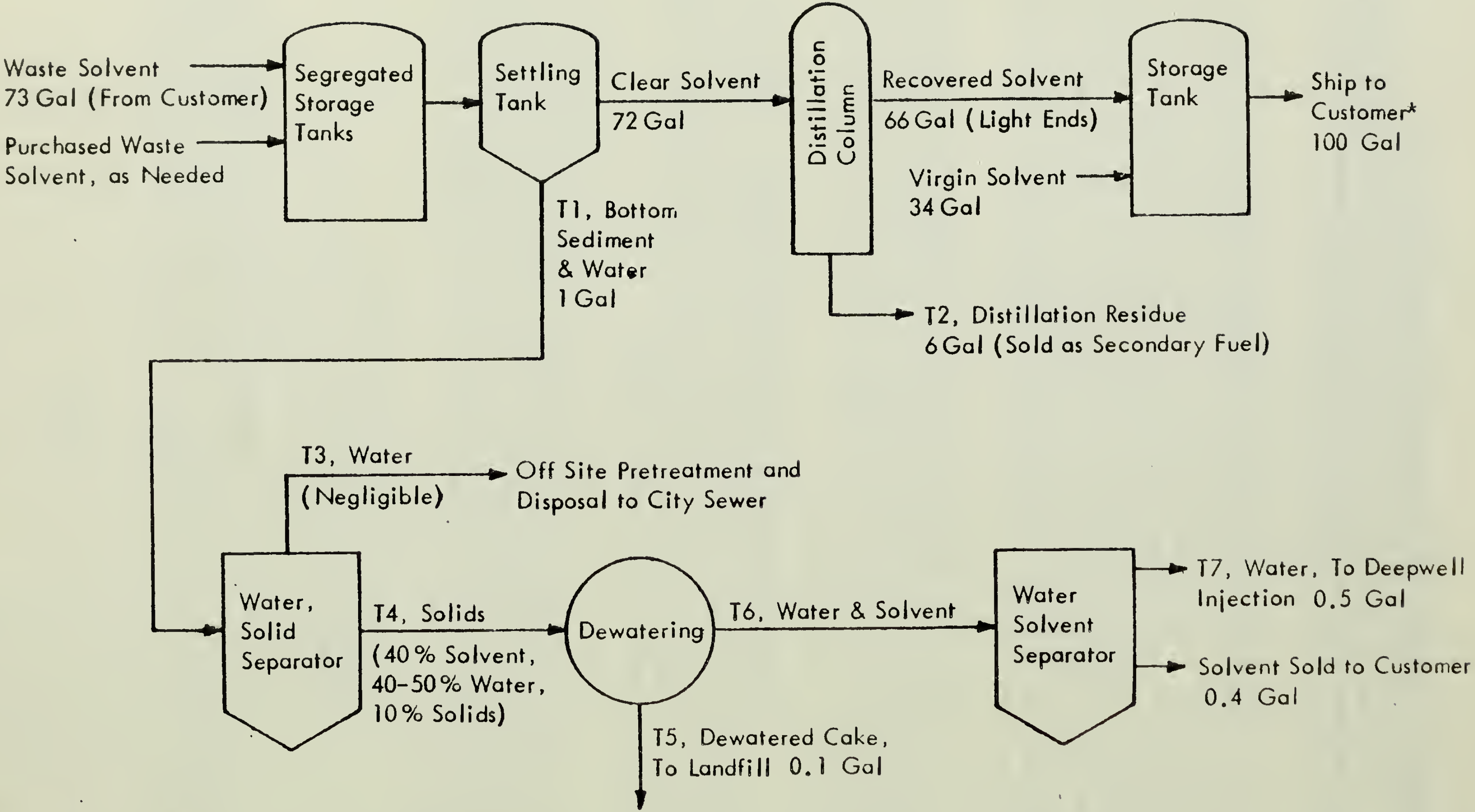


Figure 7-1. Solvent recovery process.

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* Note: Approximately 27 percent of the solvent shipped to the customer is lost, and the remaining 73 percent is returned to the processor.

Waste Management Practices and Costs. Wastewaters are deepwell injected at RCRA-approved facilities at a cost of about 20 cents per gallon--10 cents for disposal and 10 cents for transportation. Dewatered filter cake is landfilled at a cost of about $70.00 per ton--$47.00 for disposal and $23.00 for transportation. In addition, the Illinois generator fee is $2.00 per ton.

Alternatives to landfill for the dewatered filter cake include cement based stabilization/solidification at a cost of $31.00 per cubic yard, incineration at a cost of $ 800 per cubic yard, and storage in a secure landfill for later treatment at a cost of $47.00 per cubic yard. Alternatives to deepwell injection of the wastewater include biological wastewater treatment at a cost of 10¢ per gallon, and incineration at a cost of $1.50 per gallon.

A detailed analysis and summary comparison of waste management alternatives for wastewater and dewatered filter cake are presented in Appendix A-7.

Section 8: Ink Related Wastes

Ink bearing waste streams generated by the formulation of inks and the publication of a large daily newspaper were evaluated in this study. Two facilities were visited to observe the generation of these wastes.

Characteristics of Ink-Related Wastes. The hazardous waste resulting from the formulation of publication and packaging inks is generated by housekeeping procedures and off-specification products. The hazard presented by the wastes is directly related to the ink constituents.

Ink colors may be supplied by inorganic pigments or dyes containing toxic metals (e.g., lead, chromium (VI), cadmium, mercury) or cyanide compounds. Problems posed by organic pigments and dyes also may stem from the usage of benzidine-related pigments and lakes. Flammable solvents in use include various naphthas; toluene; xylene; alcohols (methyl, ethyl, isopropyl, n-propyl, sec-butyl, isobutyl, and n-butyl); 2-nitropropane; and various esters, ethers, and ketones. The hazardous waste generated by newspaper publishing is similar to that generated by ink formulation. In both of the facilities visited during this study, plant wastes could be categorized into two groups--pumpable fluids and nonpumpable semisolids.

Processes Generating Ink Wastes. The formulation of publication and packaging inks is achieved by mixing pigments, dyes, toners, resins, and solvents in the batch mode using either tanks with mixing blades or ball mills. No chemical reactions are required in the formulation process. After blending the constituents, the resulting material is filtered to yield the desired product. Note Figure 8-1 for a diagram of this process.

The rate of waste generation per 1,000 pounds of ink product at the formulation facility visited during the study was approximately:

- 3.6 gallons of pumpable solvent/ink wastes
- 0.6 to 0.7 gallon of semisolid solvent/ink residues
- 0.4 to 1.2 gallons of formulation tank rinse water and floor washing water
- 1.3 to 2.0 gallons of recoverable waste solvents (sold to a solvent reclaimer)

The operation of offset printing presses in newspaper printing generates an ink sludge which accumulates in a trough at the base of the press roller. Additional ink sludge and waste cleaning solvents are also generated by maintenance and cleanup. A large circulation paper with offset presses can generate as many as a dozen 55 gallon drums of ink sludge and half that volume of waste cleaning solvent per week.

Waste Management Alternatives and Costs. The ink formulation facility observed during this study does not land dispose any of its hazardous wastes. However, the solvent reclaimers, the secondary fuel

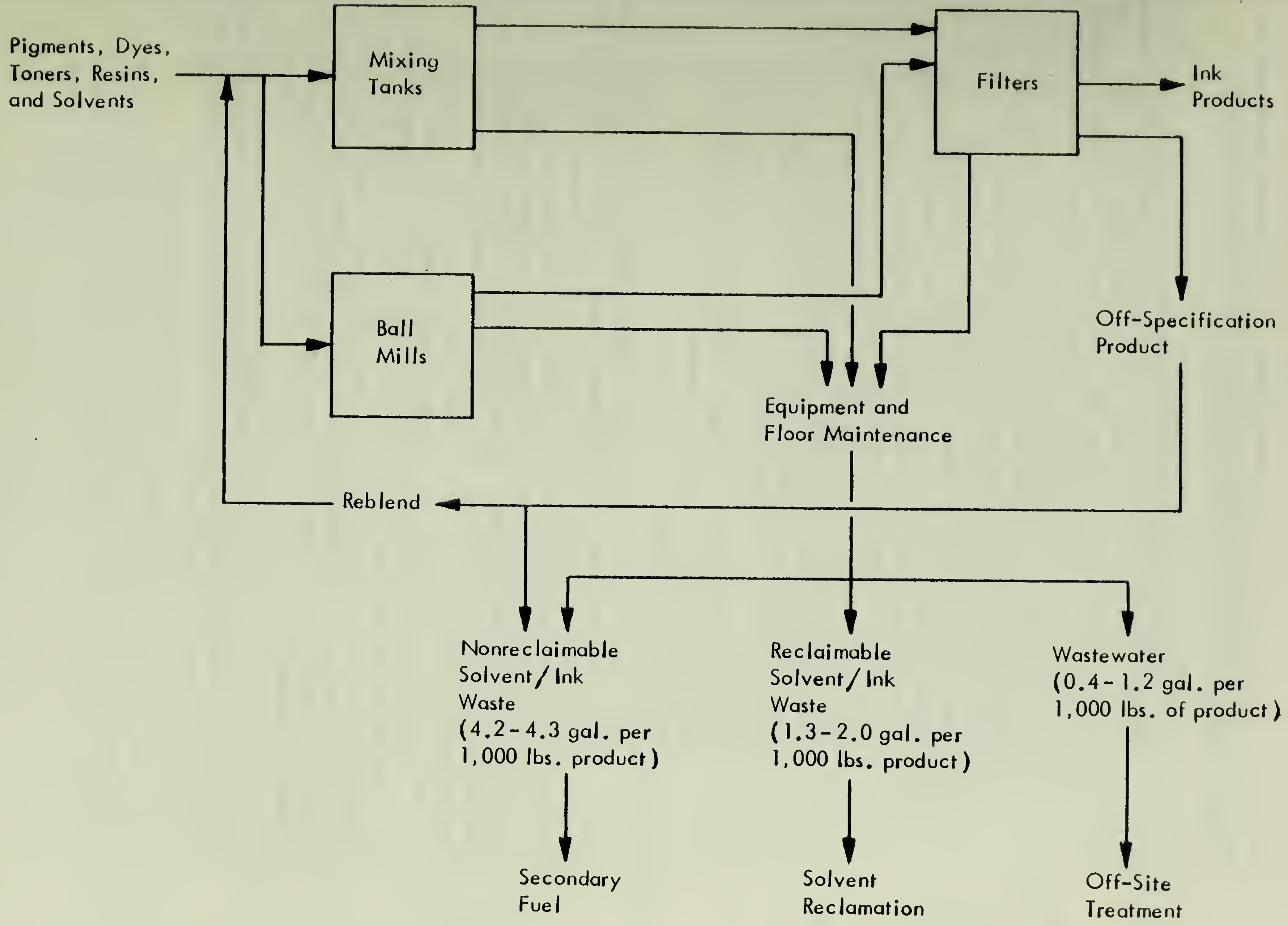
Pigments, Dyes, Toners, Resins, and Solvents
Mixing Tanks
Ball Mills
Filters
Ink Products
Off-Specification Product
Equipment and Floor Maintenance
Reblend
Nonreclaimable Solvent/Ink Waste (4.2-4.3 gal. per 1,000 lbs. product)
Reclaimable Solvent/Ink Waste (1.3-2.0 gal. per 1,000 lbs. product)
Wastewater (0.4-1.2 gal. per 1,000 lbs. of product)
Secondary Fuel
Solvent Reclamation
Off-Site Treatment

Figure 8-1. Ink formulation process and waste generation.

manufacturers, and the waste management firm that processes these wastes would generate some solid residues and wastewaters likely to end up in hazardous waste landfills or injection wells.

The newspaper publisher observed during this study sends approximately 30 percent (by volume) of the hazardous wastes generated to landfill disposal. Until recently, all of these wastes were landfilled, but a new recycling system recovered two-thirds of these wastes for reuse. For the facilities visited, the current waste management costs were as follows:

> Ink formulation - pumpable solvent/ink wastes, which are not suitable for reclamation, are picked up by secondary fuel brokers at a cost of $0.10 per gallon; similar nonpumpable sludges are handled in the same fashion, but the cost is $1.00 per gallon; pumpable waste solvents, which are suitable for reclamation, are sold to a reclaimer for $0.10 per gallon; wastewater is picked up by an off-site waste management firm (at a cost of $0.19-$0.25 per gallon) which removes the harmful contaminates (which are probably landfilled) and discharges the water in an approved manner at their treatment plant.
>
> Newspaper publishing - drummed sludges are landfilled at a total cost, including transportation, of $50 per 55 gallon drum.

The initial cost of the papers' ink/solvent recycling systems was about $16,000. Conventional calculations suggest a payback period of approximately two years; however, because the recycling systems are quickly reducing the volume of waste ink sludge and used cleaning solvent in storage as well as keeping up with the day-to-day volumes presently being generated--the systems have paid for themselves in approximately two months. Operating costs are very modest; the replacement cost for clogged filters is currently $2.00 each.

Alternatives to landfilling of the ink related sludges include off-site combustion as secondary fuel at a cost of $1.00 per gallon, on-site recycling at a cost of 50¢ per gallon, and off-site incineration at a cost of $3.30 per gallon. As indicated, the cost of the newspaper publishing recycling system is considerably less expensive than the alternative land disposal alternative.

A detailed analysis and summary comarison of the potential waste management alternatives for ink-related sludges, waste solvents, and wastewaters is presented in Appendix A-8.

Section 9: Concentrator Tailings from Secondary Brass Operations

Secondary brass facilities usually are small plants depending on scrap metal as raw material to produce brass ingots. One facility was visited in the study and the process, waste management practices, and alternatives were evaluated.

Characteristics of Concentrator Tailings. Concentrator tailings are the only hazardous waste generated by the secondary brass operations located in the Chicago area. Concentrator tailings are dark gray granular slag particles similar in size to table salt. They typically contain about 15 percent moisture, 1 percent lead, 3 percent copper, 5 percent zinc, low concentrations of other metals, and other inorganics. A sample analysis is given in Appendix A-9. Lead, which exceeds allowed levels under EP toxicity (5 ppm), is the constituent which causes this waste to be listed under Illinois hazardous waste management regulations.

Process Generating Concentrator Tailings. Auto radiators, scrap wire, and other brass-containing scrap is charged to either a rotary or a reverboratory furnace for primary smelting. Slag is removed, cooled, and broken down using a crane and wrecking ball. Particles greater than or equal to 5/8 inch are called coarse slag, and particles less than 5/8 inch are called fine slag.

Coarse slag is charged to a cupola furnace for secondary smelting. Slag from the cupola has a low lead content and is not classified as a hazardous waste using the EP toxicity test.

The fine slag (less than 5/8 inch in size) cannot be charged to the cupola furnace as the fines clog up air lines and overload the emission control equipment. This slag goes through hydrometallurgical separation. The size of the fine slag is reduced using ball mills, and is then slurried with water. The high metal content slag is separated from low metal content slag by using a vibrating slanted bed, similar to those used in ore processing. The high metal content slag is reintroduced to one of the primary smelters.

The low metal content slag (called concentrator tailings) is dried to about a 15 percent moisture level, stored in the plant site, and hauled to a secure landfill. The generation rate for this waste material is estimated at 2 to 4 pounds per 100 pounds of scrap processed. Typically, these concentrator tailings contain 1 percent lead, 3 percent copper, 5 percent zinc, and low concentrations of other metals. Figure 9-1 presents a flow diagram for a typical secondary brass operation.

Waste Management Practices and Costs. The concentrator tailings generated in this process are currently being disposed of in a secure landfill. The unit cost of this disposal varies with the volume shipped. The total unit rates charged by one disposal firm, including transportation, are as follows:

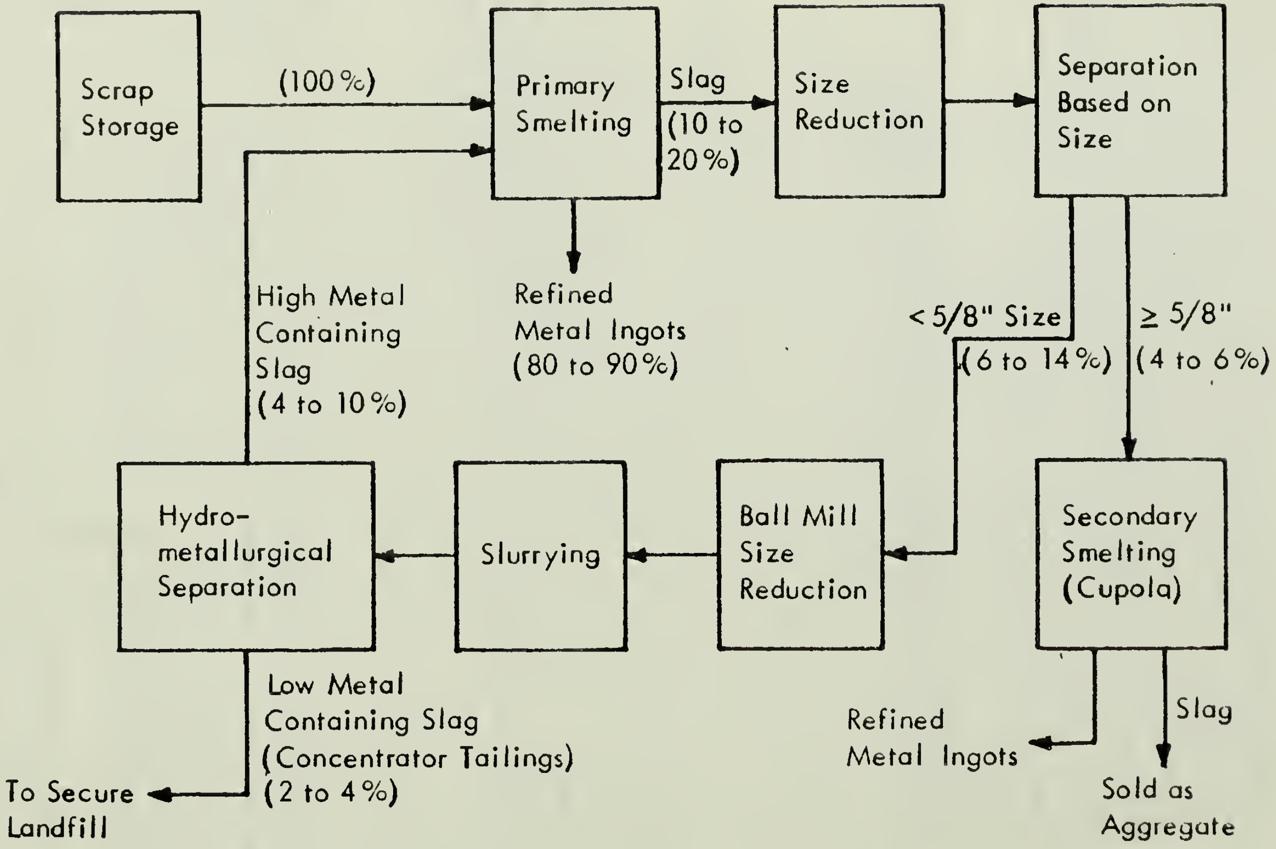

Figure 9-1. Process for secondary brass operations.

Volume Shipped (cubic yard)	$ per Cubic Yard
13 or more	34.23
12	36.25
11	38.63
10	43.52

These unit prices are for a firm located relatively close to the secure landfill (approximately 30 to 40 miles).

Alternatives to landfilling of concentrator tailings from secondary brass operations include pelletizing followed by reuse in the smelters at a cost of $10 to $20 per cubic yard, solidification followed by disposal in municipal landfill at a cost of $40 per cubic yard, and storage in a secure landfill cell for later retreival at a cost of $43 to $52 per cubic yard. Other potential alternatives to landfilling are acid leaching of lead and a central processing unit to recover metal. However, the cost associated with these treatments are not readily available. The above-listed costs reflect concentrator tailings generation of approximately 1,700 cubic yards per year.

A detailed analysis and summary comparison of potential management alternatives for concentrator tailings is presented in Appendix A-9.

Section 10: Emission Control Dust/Sludge from Electric Arc Furnace Production of Steel

Electric arc furnaces (EAFs) are widely used in the steel industry where scrap metal is the source of ferrous feed. One facility operating such a furnace was visited to gather information on hazardous waste generation and disposal.

Characteristics of EAF Dust and Sludge. The EAF is one of the major sources of particulate in the iron and steel industry. Generally the emissions are collected in fabric filters, or in a few cases by wet scrubbers. Most steel industry particulates are recycled to processes, but EAF dusts/sludges (control device catch) are not amenable to recycle because of the high concentrations of nonferrous metals particularly zinc, lead, and cadmium. Hexavalent chromium is also present at high levels.

The characteristics of the emission control device catch are dependent on scrap quality, scrap cleanliness, and type of product as well as the type and extent of fugitive emission control and the type of collection mechanism (fabric filtration or wet scrubbing) employed. The majority of the particulate emissions from EAFs consist of ferrous and nonferrous metal oxides from the smelting and refining phases of the operation. Small quantities of soot and unburned hydrocarbons can also be generated if dirty or oily scrap is charged to the furnace.

The literature reports that the average metal composition of EAF dust/sludge is approximately:

23.9 percent		iron,
7.2 percent		zinc,
0.8 percent	(7,800 ppm)	lead, and
0.1 percent	(1,000 ppm)	chromium

Process Generating EAF Dust and Sludge. The EAF is the primary process used to melt, and sometimes refine, iron and steel scrap in the secondary steel industry. The EAF is a refractory-lined, cup-shaped vessel with a refractory-lined roof. This lining may be either acidic or basic. Three graphic electrodes are placed through holes in the roof to provide the electrical energy for melting iron. The basic melt cycle proceeds in batch mode and consists of charging and backcharging, melting and refining, and tapping. Particulate emissions are generated during each of these operations. The method for containing these emissions is different for each operation. The quantity and quality of the eventual control device catch is dependent upon the type and degree of containment.

The emissions contained (or captured) from the various operations are generally ducted to a single control device for particulate removal from the gas stream. The two types of devices currently used in the United States are fabric filters and high energy wet scrubbers (about 98 percent of the installations currently use fabric filters and less than 2 percent use scrubbers). Note Figure 10-1 for a flow diagram of the EAF process.

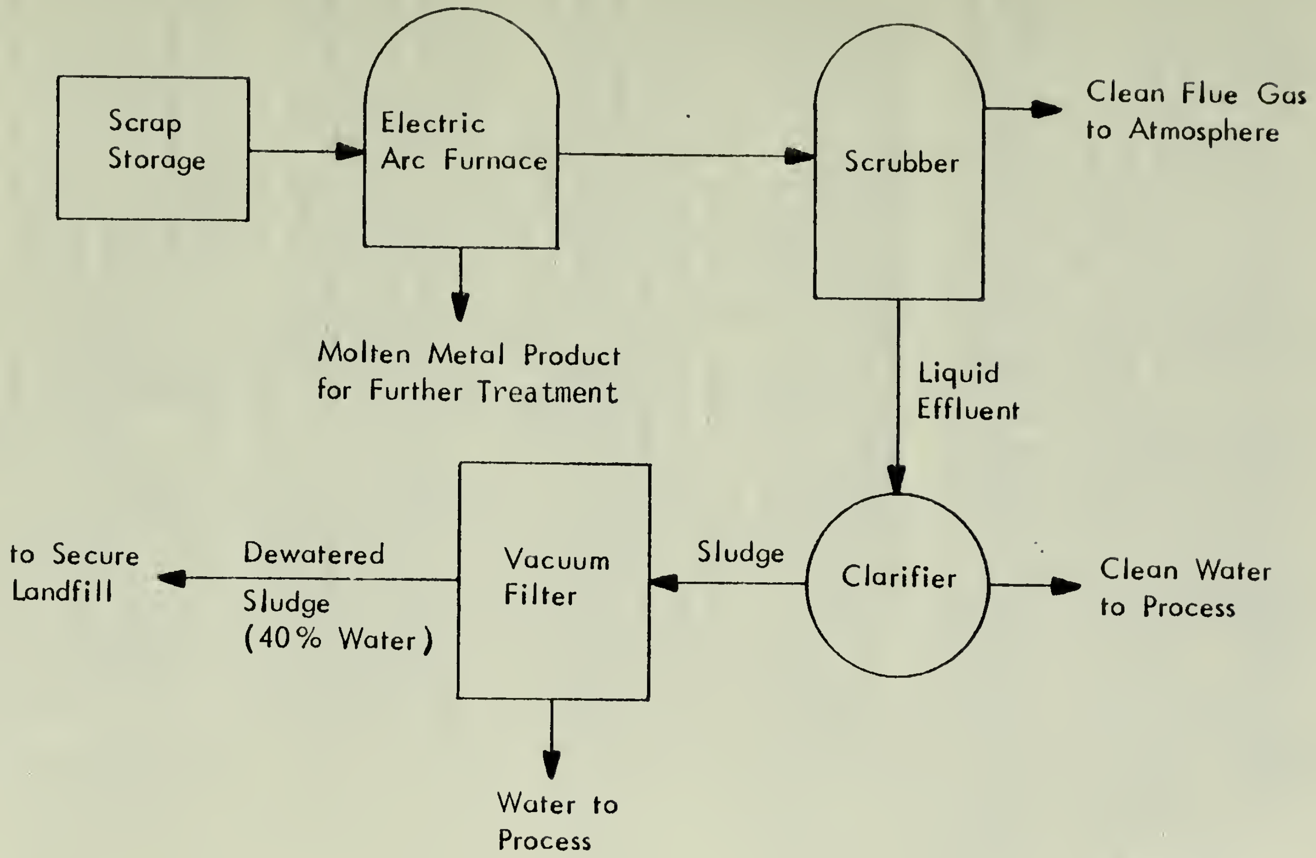

Figure 10-1. Product flow diagram for secondary steel operations.

On a dry basis, the quantity of material in the vacuum filter from steel-making EAFs are reported to vary over a range of 15 to 40 pounds (0.8 to 2 percent) of particulate per ton of metal produced.

Waste Management Alternatives and Costs. At the plant visited during this study, EAF dust/sludge is landfilled in a hazardous waste landfill. However, representative hazardous waste landfill disposal costs are not incurred. A nearby company-owned and -operated hazardous waste landfill permits disposal at no charge other than waste transportation costs. Normally, disposal costs for this type of waste would fall in a range of about $34 to $43 per ton including transportation.

Because landfilling of waste from EAF control devices is becoming costly and suitable sites are more difficult to locate, a number of waste mangement alternatives are being examined by the steel industry; these include the following:

> Recovery or recycle of usable components of the waste, such as recovery of zinc, nickel, lead, chromium, and other metals; net profit for some of these processes range from $24 to $75 per ton.
>
> Waste treatment to reduce the hazard presented by the material, such as stabilization/solidification to produce a less hazardous material permissible in municipal landfills; costs for such processes are approximately $30 per ton (including land disposal of the treated material) for quantities of approximately one million gallons per year.
>
> Reduction of waste volume, such as the dewatering of scrubber sludges; the conversion of wet scrubbers control systems to baghouse systems; or the processing of only high quality clean scrap (the technical feasibility of these approaches is highly questionable--no cost data were readily available and none were approximated).

The metal recovery processes are applicable to emission control dusts, but not scrubber sludge. The most feasible waste management alternative to land disposal for the scrubber sludge is stabilization/solidification. This alternative may be moderately higher than landfilling the sludge depending upon the comparative transportation costs.

Alternative waste management practices and costs are discussed in greater detail in Appendix A-10.

Summary of Comprehensive Assessment

Waste Streams Evaluated. Approximately 22 million gallons of hazardous wastes are reportedly being land disposed off-site in the three counties around Chicago. These wastes, generated by about 240 different facilities, were classified into 22 waste categories as shown in Table 7. Seven of the 22 waste categories were selected for further consideration on the basis of volume, toxicity, and associated risks. The seven waste categories selected for further study were alkaline wastes, distillation residues, ink and ink solvents, metal wastes, plating wastes, solvents, and miscellaneous waste. Ten major waste streams were chosen from the seven waste categories for detailed evaluation. After 15 on-site facility visits, a few of the ten chosen waste streams were subdivided into additional waste streams. Thus, a total of 19 waste streams were evaluated, as shown in Table 7. These 19 waste streams accounted for nearly 12 million gallons of hazardous waste land disposed in the three-county area in 1982.

Feasible Waste Management Alternatives. Information gathered during site visits included waste characteristics, processes generating the wastes, waste generation rates, current waste disposal and costs, and alternate disposal methods. In cases where facilities considered this type of information as confidential, published literature and other industry contacts were used to evaluate those processes responsible for waste production.

Based on the above information, each of the waste streams were evaluated with respect to alternatives to land disposal. Cost estimates were developed for feasible alternatives, and other considerations, such as regulatory concerns, were evaluated.

These evaluations suggested that practical alternatives to land disposal exist for a large portion of these wastes. They are incineration, burning in boilers or other high temperature processes as secondary fuel, stabilization/solidification, resource (metal) recovery by various methods, and metal recycling. Practical alternatives for specific waste streams were presented earlier in Summaries of Waste Stream Evaluations and are presented in detail in Appendix A. In general, it appeared that thermal destruction (incineration, burning in boilers) would be a practical and environmentally more acceptable alternative for wastes that are primarily organic in nature. Similarly, resource recovery and recycling offered better alternatives for wastes that contain high concentrations of metals. Stabilization/solidification appears to be a feasible alternative for those wastes that contain low concentrations of metals such that recovery is not feasible. Our cost analyses suggest that some of these alternatives generate revenues for the generator, while offering better environmental protection.

The next section presents a very brief summary of the current land disposal quantities and the proposed quantities that would be land disposed if the alternatives defined in this section were to be implemented.

PROJECTIONS OF FUTURE LAND DISPOSAL IN THE THREE-COUNTY AREA

In 1982 approximately 21.7 million gallons of liquid hazardous waste was land disposed in the three-county area. The waste categories with the largest land disposed amounts were: alkalines, hydrocarbons, distillation residues, plating, and miscellaneous. In general, each waste category can be identified by a few particular types of waste. The alkaline category includes, primarily, metal hydroxide sludges and caustic wastewater. The major waste quantity in the hydrocarbon category is an acetone/water solution. Two wastes exemplifying distillation residues are still bottoms from paint production, and concentrator tailings. The most typical waste from the plating category is electroplating sludge from wastewater neutralization. Numerous waste types are contained in the miscellaneous category.

The waste streams for which the detailed waste stream evaluations are applicable are shown in Table 8. The evaluations are judged applicable to 68 identified waste streams comprising 14.8 million gallons; these waste streams fall within seven of the identified waste categories. The waste stream evaluations identified several waste management alternatives to land disposal which appear feasible for selected wastes.

Stabilization/solidification processes appear cost competitive with landfilling for large quantities of metal hydroxide sludges. The quantity of waste is the determining factor in the feasibility of this alternative. Generation of sludge quantities of 60,000 gallons per month or greater may justify development of an on-site stabilization/solidification treatment process. On-site treatment of smaller quantities is not likely to be cost competitive with land disposal. Commercial stabilization/solidification may be feasibile in certain cases pending transportation costs.

Thermal combustion and pelletizing of waste were examined for distillation residues. One aniline waste still bottom from paint manufacturing will soon be burned as a boiler fuel. A quite different residue, concentrator tailings from secondary brass manufacturing, may conceivably be pelletized for sequential reuse in smelters.

For ink and ink solvents from newspaper publishing, filtering systems have been developed to recover approximately two-thirds of the waste currently land disposed.

Decreases in land disposal of metal wastes have also been observed. Several feasible alternatives have been identified. One alternative includes sending the waste to a commercial treatment facility where the waste is stabilized/solidified through the use of a proprietary process. Another alternative is the recovery of metals from the waste.

Table 8

PROJECTED LAND DISPOSAL OF OFF-SITE MANAGED LIQUID HAZARDOUS WASTE STREAMS IN THE THREE-COUNTY AREA

	Land Disposal 1/		Waste Streams for Which Evaluations are Applicable 1/		Estimated Quantities with Feasible Alternatives to Land Disposal		Projected Future Land Disposal	
Waste Categories	No. of Streams	Gallons	No. of Streams	Gallons Land Disposed	No. of Streams	Gallons	No. of Streams	Gallons Land Disposed
Acids	12	239,865	-	-	-	-	12	239,865
Alcohols	3	9,456	-	-	-	-	3	9,456
Aliphatic HC	0	0	-	-	-	-	0	0
Alkalines	22	11,700,337	14	9,737,289	4	9,287,331	18	2,413,006
Aromatic HC	6	15,849	-	-	-	-	6	15,849
Chemical intermediates	0	0	-	-	-	-	0	0
Hydrocarbons	21	1,649,114	-	-	-	-	21	1,649,114
Distillation residues	5	1,288,756	3	1,216,829	2	1,115,627	3	173,129
Heat treating salts	1	15,000	-	-	-	-	1	15,000
Ink, Ink solvents	5	43,680	4	33,880	4 2/	23,716	5 2/	19,964
Lab wastes	0	0	-	-	-	-	0	0
Metal wastes	15	115,092	4	72,057	4 2/	60,747	12 2/	54,345
Paint, Paint solvents	23	139,909	-	-	-	-	23	139,909
Paint strippers	3	14,120	-	-	-	-	3	14,120
Paper manufacture	0	0	-	-	-	-	0	0
Pesticides	0	0	-	-	-	-	0	0
Photographics	0	0	-	-	-	-	0	0
Plating	21	437,601	20	404,601	20 2/	80,920	21 2/	356,681
Solvents	9	131,900	3	28,700	3 2/	25,700	8 2/	106,200
Miscellaneous	93	5,929,658	20	3,350,349	15 2/	1,855,281	90 2/	4,071,377
Industrial formulations	0	0	-	-	-	-	0	0
Polymer wastes	1	23,624	-	-	-	-	1	23,624
Total	240	21,753,961	68	14,843,705	52 2/	12,452,322	227 2/	9,301,639

1/ Represents waste land disposed in the three-county area in 1982.
2/ Some of these waste streams are divided between land disposal and other waste management alternatives.

Source: Franklin Associates, Ltd.

Metal recovery techniques appear very attractive in reducing quantities of electroplating sludge. A reduction of land disposed sludges can reach as high as 50 percent. However, the total feasible reduction in land disposed electroplating sludge is estimated at 20 percent.

Stabilization/solidification techniques may also be cost effective for certain other inorganic wastes including dewatered filter cake from solvent recovery and electric arc furnace sludge from secondary steel operations. The feasibility of this treatment is, again, sensitive to the quantities treated and the assumption that the treated waste may be disposed at a nearby municipal waste landfill.

The waste management alternatives to land disposal determined to be feasible were chosen based upon economic, technical, and regulatory criteria. By assuming the use of these alternatives where they have been determined to be feasible and by, further, accounting for changes in land disposed quantities since 1982, projections of future land disposal in the three-county area have been made.

Estimated quantities of off-site managed liquid hazardous waste for which there are feasible alternatives to land disposal are presented in Table 8 by waste category. The total quantity of such waste within the three-county area is about 12.5 million gallons or approximately 58 percent of the land disposed waste in 1982. This leaves only 9.3 million gallons of off-site managed waste for continued land disposal in the three-county area if the feasible waste management alternatives are implemented. While the potential for cost effective reductions in land disposed quantities of hazardous waste is quite encouraging, the time required to effect these reductions is unknown.

The waste management alternatives considered in developing the projections in Table 8 are either economically competitive currently or are expected to be competitive in the near future. During the study the land disposal fee paid to the State of Illinois, by hazardous waste generators, was increased from approximately $2 per cubic yard to $6 per cubic yard. This alone has improved the economics for alternatives to land disposal. In addition, the cost for land disposal is expected to continue increasing above inflationary levels thereby improving the attractiveness of alternatives.

APPLICATION OF STUDY RESULTS

This final section of the report presents an overview of the potential application of the results of the study. It provides an insight into how the study can be applied to the various industries located within the three-county area to assist in the reduction of the quantities of waste currently being land disposed. The specific areas of waste generation and disposal are reviewed as a final guideline for the application of the results within the study limitations. Finally, the application of the study with respect to other waste management areas is reviewed for the three-county area and the remainder of the State of Illinois.

APPLICATION TO INDUSTRY

The problems associated with the disposal of hazardous wastes in landfills throughout the United States are well documented and have been highly publicized. The Hazardous Waste Research Program administrered by ENR is directed at the development of alternatives to the land disposal of hazardous wastes in Illinois. The study reported here was initiated as part of the overall ENR Hazardous Waste Program to develop an information base for the three-county area relative to liquid hazardous waste generation, current off-site treatment/disposal practices, and viable waste management alternatives to land disposal. The overall perspective for this program is to provide assistance to government officials and industry representatives in the potential reduction of the quantities of hazardous waste currently being disposed in landfills.

In one phase of the study, 10 liquid hazardous waste streams were chosen for detailed evaluation. Among the waste parameters investigated were the nature of the generated waste, quantities produced, current land disposal practices and costs, and potential waste management alternatives and their projected costs. These evaluations were performed in concert with industry personnel and represent their insights as well as the technical expertise of the two research groups performing the study. This report is intended to be used as a source of technical assistance by small and large scale generators of hazardous waste. The technical information contained in this report may be used by industries to evaluate their current methods and costs of waste management with respect to potentially more cost-effective alternatives.

A second aspect of the report is the identification of those alternative waste management approaches with the greatest potential impacts on current landfill procedures in Illinois. These impacts are not only on the total volume of the waste being land disposed, but also on the nature of the waste. Many of the potential alternatives result in a change in the nature of the waste with a reduction in the potential for environmental contamination. In addition, a significant reduction in the current volume of liquid hazardous waste land disposal can be achieved, as was discussed in the previous section. Evaluation of the alternative waste management practices for selected wastes on an industry-by-industry basis could result in a reduction in disposal cots as well as a reduction in the volume of waste transported to the landfill.

RELATIONSHIP OF CURRENT STUDY TO OTHER WASTES

The study is directed only at those liquid hazardous wastes which are generated and land disposed off-site in Cook, Lake, or DuPage Counties. Liquid hazardous wastes which are land disposed on company premises were not within the scope of the study.

One of the major sources of liquid hazardous wastes disposed in landfills in the three-county area is waste generated by companies outside the area and transported into the area for disposal. A complete assessment of wastes generated outside the three-county area, based on the annual facilities reports, was beyond the scope of the study; however, a cursory overview of these reports indicated that the quantities may be substantial. Thus, the data bases developed by the study in Phase 1 are based primarily on the reports of hazardous waste generators in the three-county area and do not include those quantities generated outside the area. In a similar manner, companies within the area generate liquid hazardous waste and may transport the waste outside the area for disposal. The scope of the current study did not allow for an evaluation of those wastes generated in the area but landfilled at sites outside the area in either Illinois or an adjoining state.

Overall, the study of the three-county area has provided an initial data base for approximately half of the liquid hazardous waste generated and disposed in landfills in the State of Illinois. Due to the scope of the study, certain areas have not been evaluated. The expansion of the study to other major waste generation/disposal areas in the State of Illinois could be used to provide an insight into the waste disposal practices and, perhaps more importantly, provide a mechanism whereby a reasonably accurate assessment can be made of the generation, transport, and land disposal of liquid hazardous wastes throughout the State.

ON-SITE WASTE MANAGEMENT

From the data base developed in Phase 1 of the study, it was apparent that substantial quantities of liquid hazardous waste are being generated and disposed on-site by the individual companies. These quantities represent a significant component of the overall picture of land disposal of liquid hazardous waste in Illinois. Because these wastes are basically of the same general type as those land disposed off-site, the potential for environmental contamination is similar.

From the data produced in Phase 1 from generator and facility reports, an insight can be gained from the magnitude of the quantities of waste managed on-site. Information from additional state files could be used to identify permitted on-site facilities and the quantities of waste disposed at these permitted facilities. A data base similar to the one generated in the study in Phase 1 could be developed for the permitted on-site facilities.

After the nature and quantity of the liquid hazardous wastes have been developed, an evaluation of potential alternaitve treatment or disposal methods could be conducted in much the same manner as that conducted in Phase 2 of the current study. Because of the existing data bases, a study of the three-county area could be conducted on a "pilot" scale to evaluate the results and their potential usefulness. If appropriate, a similar evaluation for the entire state should be considered.

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Abstract (Limit: 200 words)

Cook, DuPage and Lake counties within the State of Illinois are the geographic areas of this study. The current practices of liquid hazardous wastes generation and management of selected waste streams which are land disposed in Illinois are quantified and analyzed in this study. Also, within this study report, generic flow diagrams and descriptions of processes pertinent to the waste streams studied were developed; alternative waste management practices for these waste streams were identified, described and analyzed; and the study methodology is described.

Major findings are: a) in 1982 in the Chicago area including Cook, DuPage and Lake counties generate and estimated total of over 34 million gallons of liquid hazardous wastes that were managed off-site of which 22 million gallons were land disposed; b) feasible waste management alternatives exist for large quantities of liquid wastes currently being land disposed; c) nearly 90% of the total (over 30 million gallons) volume was generated in Cook county; d) six major industry groups namely foundries, general manufacturing and fabrication, paint manufacturing, plating, primary steel production and miscellaneous industries generated about 90% of the waste.

Document Analysis a. Descriptors

Hazardous wastes	Hazardous pollutants
Liquid Hazardous wastes	Pollutants
Industrial wastes	Land disposal
Liquid wastes	

b. Identifiers/Open-Ended Terms

Hazardous waste management	Illinois
Waste treatment technologies	
Waste disposal technologies	
Alternatives to land disposal	

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